

STRUCTURAL HOLES AND SIMMELIAN TIES: EXPLORING SOCIAL CAPITAL,  
TASK INTERDEPENDENCE, AND INDIVIDUAL EFFECTIVENESS

Scott L. Engle, B.A., M.B.A.

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APPROVED:

Vickie L. Goodwin, Committee Co-Chair

Grant Miles, Committee Co-Chair

Warren E. Watson, Committee Member

Robert J. Pavur, Committee Member

Lynn Johnson, Department Chair

Jared E. Hazelton, Dean of the College of  
Business

C. Neal Tate, Dean of the Robert B.

Toulouse School of Graduate Studies

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Two contrasting notions have been put forward on how social capital may influence individual effectiveness in organizations. Burt (1992) sets forth the informational and control advantages that are possible by building an open network characterized by large numbers of structural holes. In contrast, Coleman (1990) and Simmel (1950) have suggested that network closure, exemplified by large numbers of Simmelian ties, enables actors to develop trust, cohesiveness, and norms which contribute to effectiveness. Simmelian ties are strong, reciprocal ties shared by three actors.

It is proposed that an actor's network cannot be dominated by both structural holes and Simmelian ties. Thus, this study examines whether a moderating variable is at work. It is proposed that the actor's task interdependence in the workplace influences the relationship between network closure and individual effectiveness. Actors in less task interdependent environments will benefit especially from the information and control benefits afforded by a network characterized by structural holes. Conversely, actors in highly interdependent environments will benefit especially from the creation of trust and cooperation that result from large numbers of Simmelian ties.

Data was collected on 113 subjects in three organizations. Subjects were asked to rate the strength of their relationship with all organization members and their own level of task interdependence. Contrary to expectations, nearly all subjects reported high levels

of task interdependence. Raters in each organization provided individual effectiveness measures for all subjects. Hypotheses were tested using hierarchical set regression and bivariate correlation. The results indicated support for the hypothesized relationship of Simmelian ties with task interdependence. When examining all cases, no support was found for the hypothesized relationship of structural holes and Simmelian ties with individual effectiveness and of structural holes with task interdependence. Nonetheless, additional analyses provided some indication of an association between Simmelian ties and individual effectiveness. Task interdependence did not moderate the relationships between either Simmelian ties or structural holes and individual effectiveness.

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## CHAPTER 1

### INTRODUCTION

Managers always have known intuitively the importance of relationships in the workplace, paying careful attention to “who they know,” not just “what they know” (Lipnack & Stamps, 1994). Indeed, every organization can be seen as a complex web of interpersonal relationships. An individual in the organization may go to some persons for work-related advice, to others when seeking allies in a contentious decision, and still others when seeking emotional support. Similarly, organizations operate in arenas composed of diverse sets of suppliers, customers, and competitors to whom the organization may be tied in networks of contracts, corporate interlocks, informal alliances, and other relational mechanisms. Since the late 1970’s, advances in mathematical modeling and the accessibility of computer programs have fueled scholarly interest in these “social networks” and a more general network perspective on organizations (Nohria, 1992; Scott, 1991). A 1990 colloquium hosted by the Harvard Business School broadened the audience for “network” research, as did Ron Burt’s seminal work, *Structural Holes* (1992). For example, Burt’s book was the subject of *Administrative Science Quarterly*’s first review symposium in 1995, for which the editors select a relatively recent and especially important book for several lengthy reviews.

Still, despite advances in concept and methodology, social network analysis remains much as Jeffrey Pfeffer saw it when he observed that it is “ . . . a paradigm and

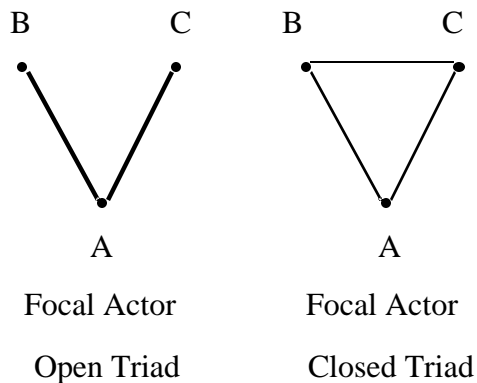
framework more than a theory, and more promise than fulfilled potential" (1982: 276).

While some theoretical strides have been made in the last decade (Nohria, 1992), network studies have remained largely descriptive, with little attention to how networks are created and how they change (Ibarra, 1992). In an attempt to achieve completeness, researchers sacrifice the subtleties and nuances that characterize informal relations (Kanter & Eccles, 1992). Finally, it often ". . . seems that measures of structure of informal relations are chosen because they are available, rather than because they have received theoretical or inductive empirical support" (Barney, 1985: 2).

Salancik (1995) held that rather than focusing on how to apply network concepts and methods to extant organizational theories, network analysts should advance the knowledge of organizations by constructing network theories of organization. Further, he suggested that "a network theory should do one of two things: (1) It should propose how adding or subtracting a particular interaction in an organizational network will change coordination among actors in a network; or (2) It should propose how a network structure enables and disables the interactions between two parties" (p. 348). As will be elaborated upon, this study proposes a theoretical model that fulfills Salancik's (1995) first theoretical function. Broadly put, this study examines potential implications for organizational coordination and individual effectiveness of changing the structure of ties among triads of actors. More specifically, the study explores the consequences of adding a strong relationship between actors who are each strongly connected to a third actor. This, in effect, closes the triad composed of the three actors, as illustrated in Figure 1; that is, closing the triad binds all three actors in a web of strong and reciprocal

relationships. For instance, three actors working in an environment where they are highly dependent on one another may benefit from high trust levels and strong group norms within the triad that enable them to rely on high levels of mutual adjustment to accomplish the needed coordination among themselves. Thus, by enhancing the development of norms and trust, strong and reciprocal ties among the actors may increase the effectiveness of the actors in the workplace.

Figure 1  
Open v. Closed Triads



#### Statement of the Problem

Burt (1992) notes that there are at least three forms of capital: financial capital, human capital, and social capital. Whereas financial capital and human capital are the property of individuals, social capital is owned jointly by the parties to a relationship. For Burt, social capital can be thought of in two ways. First, social capital can be access to people with specific resources that are valuable (e.g., access to a rich uncle or the family friend whose company has a job opening). As Burt notes, this “who” focused conception of social capital has dominated most social network research. In the second

conception, the social structure itself is social capital; Burt characterizes it as “how” focused. This characterization refers to the social capital individuals enjoy when only they have contacts in two important departments, or the social capital a firm derives from having a larger network of contacts than its competitors. Admittedly, it can be difficult to sort out “who” and “how.” Nonetheless, in this study, the focus is primarily on the second conception, the “how,” examining structural influences on a person’s effectiveness in the organization.

When building a network, an actor faces a fundamental conflict that will shape the network, and the benefits and costs that accrue to the actor. On the one hand, the actor could build a network composed of many open triads, as in Figure 1, where she is the individual in the center of the triad. On the other hand, the actor could emphasize network closure by facilitating the creation of closed triads. In other words, the focal actor could keep her contacts disconnected or she could help those to whom she is directly tied build direct ties between themselves.

There is substantial theoretical and empirical support for the idea that important information and control benefits flow to actors who are connected to others who are themselves not connected, that is by building a network that is dominated by open triads (Brass, 1992; Burt, 1992; Krackhardt, 1992). The most complete theoretical expression of this view is Burt’s (1992) theory of structural holes, which builds on the early work of Granovetter (1973). Structural holes describe the space between two actors who lack a direct tie between themselves. In Burt’s conception, competitive advantages flow to

actors whose networks are dominated by structural holes between other actors in the network, creating information and control benefits for the focal actor.

A contrasting, though complementary, view of social capital is provided by Coleman (1990), Simmel (1950), and Krackhardt (1992, 1996). In this view, social capital is a means of developing trust and enforcing behavioral norms among a set of actors, thus enabling cooperation toward common objectives. Network closure, exemplified by the closed triad in Figure 1, is necessary to the creation of this form of social capital. In this view, the successful actor will be one who optimizes the network for what Krackhardt has termed “Simmelian ties.” In Figure 1, a Simmelian tie would be the strong tie that closes the triad. Though this view of social capital has not received as much empirical study as has the open network view of Burt and Granovetter, several recent studies lend support to Coleman’s and Simmel’s theories (Krackhardt, 1992, 1996; Walker, Kogut, & Shan, 1997; Uzzi, 1997).

The difficulty lies in reconciling these two contrasting views of network structure. Any actor’s personal network cannot be dominated by both structural holes and Simmelian ties. Yet, the empirical evidence (to be reviewed in Chapter 2) suggests that increasing levels of each are associated with positive outcomes. One explanation is that there is a moderating variable at work, which influences the relative significance of the relationships of both structural holes and Simmelian ties with outcomes. Indeed, a principal research question of this study is whether an actor’s task interdependence with others in his or her network moderates the relationship between both structural holes and Simmelian ties and the actor’s effectiveness. Thus, this study tests a network model that

accounts for the moderated effects of task interdependence on the relationships between both structural holes and Simmelian ties and individual effectiveness in the organization.

### Theoretical Foundation

The benefits of an open network are captured in Burt's (1992) theory of structural holes. The term, structural holes, was coined by Burt to describe a network structure that was theorized to be optimally efficient and effective in gaining competitive advantage. Though a complete description of Burt's theory will be left to Chapter 2, in general terms, actors with a social network that is rich in structural holes are connected to others who are themselves not connected, as in the open triad of Figure 1. The ties between actors in an open network are, thus, non-redundant. An actor's contacts are redundant to the extent that (1) the contacts share a direct tie between themselves or (2) the contacts are tied to others who are themselves tied to the actor. In either case, much the same information is likely to be learned from one contact as from the other. Further, if the contacts are non-redundant, control strategies can be exercised that would be unavailable if the contacts share a direct tie. For example, if a firm has two or more customers, different prices can be quoted to them (all else equal) only so long as they have no relationship by which they can learn what each other paid.

Burt (1992) proposed that persons, firms, and even industries, with higher levels of structural holes will perform better. At the level of the individual, Burt tested his theory by examining the promotion rates of several thousand managers in a large Fortune 500 firm. Consistent with his theory, he found that structural holes were correlated significantly with promotion rates. Though supportive of the theory, Burt's study was

limited by the fact that he looked at data collected within only a single firm, included only managers, and used a single dependent variable, promotion rate. Thus, as will be detailed in Chapter 3, Burt's work will be extended by including all levels of employees, including several firms, and by using a more generalized indicator of individual effectiveness.

In contrast to Burt's structural holes, Krackhardt (1996) has coined the term "Simmelian tie" to describe the closing of the triad in Figure 1, thus aligning his work with Georg Simmel who was one of the first sociological theorists to examine the nature of the closed triad. Both Simmel (1950) and Coleman (1990) have theorized at length about the implications and benefits of closing the triad. For Coleman, closing the triad, or any network composed of three or more actors, is a necessary condition for the development of norms and also enables the maximization of group trust, in that closure results in persons being trusted to the extent justified by their trustworthiness. Similarly, Simmel contrasts the triad with a dyad, noting that in a closed triad, individuality, individual power, and conflict are all reduced, thereby enhancing the development of group identity, group cohesion, socialization, and the development of norms. Thus, just as one might expect that individuals will benefit from the information and control benefits of an open network, their reputation for trustworthiness and their identification with the group are enhanced by network closure.

One explanation for evidence supporting two contrasting theories is that a moderating variable is at work. In this study, it is proposed that the task interdependence of the focal actor with other actors in the organization moderates the relationships of



structural holes and Simmelian ties with the focal actor's effectiveness. Task interdependence refers to the extent to which work elements or work processes are interrelated so that changes in one element affect other work elements. Thompson (1967) distinguishes among three broad types of task interdependencies. In pooled coupling, the actors share resources, but otherwise work independently. In sequential coupling, the actors pass work off one to another, similar to a linear assembly line. In reciprocal coupling, the elements of work relate to each other as both inputs and outputs (i.e., the actors feed work back and forth among themselves) (Scott, 1992). Reciprocal coupling represents the highest degree of task interdependence (Mintzberg, 1979). Further, the greater the degree of task interdependence, the more resources that must be devoted to coordination (Scott, 1992). Thus, work based on significant reciprocal coupling, where inputs and outputs move among the actors variously and continuously requiring ongoing reciprocal feedback, often requires the use of mutual adjustment as the coordinating mechanism. In such cases, standardization of work, outputs, and skills are simply insufficient to meet the demand for information exchange and joint action by the actors.

Because highly interdependent groups must rely on mutual adjustment to accomplish many of their complex tasks, it is not surprising that such groups have been found to exhibit high-quality informal social processes with strong norms supporting high levels of cooperation and effort (Wageman, 1995). Similarly, firms that are strategically interdependent have been found to be more likely to form alliances than non-interdependent firms, especially if they share a common third-party tie (Gulati, 1995). Thus, it may be that informal structures, such as Simmelian ties, which promote the

development of group norms, such as norms of cooperation and reciprocity, and also promote group trust and cohesion are positively correlated with task interdependence. Thus, the relationship between Simmelian ties and individual effectiveness may be strengthened in work environments characterized by high levels of task interdependence.

In contrast, structural holes promote the accumulation of information and control benefits for the focal actor rather than the development of high-quality social processes. Thus, it may be that a network optimized for structural holes may be strongly associated with individual effectiveness for actors working in environments characterized by low levels of task interdependence, that is, environments characterized by competition between the actors rather than cooperation between them.

#### Purpose of the Research

The purpose of this research is to test a model of the relationship between network structure and individual effectiveness. Specifically, the study examines the direct and moderated effects of task interdependence on the relationships between structural holes and Simmelian ties in an actor's personal network of workplace relations and that actor's effectiveness in the workplace. It attempts to answer the following questions:

- 1. Are structural holes significantly related to individual effectiveness?*
- 2. Are Simmelian ties significantly related to individual effectiveness?*
- 3. Does task interdependence moderate the structural holes-effectiveness relationship and the Simmelian ties-effectiveness relationship?*

### Significance of the Research

As noted earlier, network analysts have made little progress in developing a distinct network theory of organization (Salancik, 1995). Though built on established streams of sociological theory and empirical evidence, the structural hole construct (Burt, 1992) and the Simmelian tie construct (Krackhardt, 1996) only recently have been introduced. Consequently, there is still little published empirical work utilizing these network constructs or otherwise exploring their relationships with other variables of interest. In the only published work that utilizes both constructs, Sparrowe and Liden (1997) note the contrasting advantages and the complementary nature of structural holes and Simmelian ties, using the constructs to develop a set of untested propositions regarding the role of social structure in leader-member exchange. Thus, one of the most important contributions of this study is its theoretical exploration of the relationship between these variables and the suggestion that task interdependence may account for, at least in part, the contrasting advantages.

Finally, this study has practical significance in the workplace. The importance of social networks in the workplace has long been recognized by managers, but network researchers have been able to provide little in the way of practical, concrete, and understandable advice about the relationship between specific social structures and the effectiveness of individuals or groups in the workplace. This study contrasts two approaches to building personal networks (structural holes via open triads versus Simmelian ties via closed triads), and suggests that actors in the workplace should select

the more appropriate approach based on the actor's task interdependence to maximize their individual effectiveness.

### Definition of Terms

The following section contains conceptual definitions of key terms used in this dissertation. The terms are organized alphabetically.

Cohesion: the degree to which two actors are directly tied (Burt, 1992).

Embedded Tie: a strong tie joining two actors, which is characterized by trust, fine-grained information exchanges, and joint problem-solving arrangements (Uzzi, 1996).

Individual Effectiveness: The degree to which an individual in the workplace regularly and consistently meets the requirements of his/her position by producing the expected amount of accurate and quality work within established time frames.

Network Closure: the degree to which every actor in a network is directly or indirectly connected to every other actor (Coleman, 1990).

Redundancy: the degree to which an actor's different contacts provide the same information (Burt, 1992).

Simmelian Tie: a strong and reciprocal tie joining two actors when the two actors are each strongly and reciprocally tied to at least one common third party (Krackhardt, 1996).

Structural Embeddedness: the degree to which an actor's actions and outcomes, social and economic, are affected by the larger structure of social relations of which the actor is part (Granovetter, 1985, 1992).

Structural Equivalence: the degree to which two actors are linked to the same set of actors but not to each other (Scott, 1991).

Structural Hole: the absence of a relationship between two actors (Burt, 1992).

### Organization of the Dissertation

This dissertation is organized into five chapters. This chapter has (1) outlined the research problem and explained the purpose of the research, (2) demonstrated the significance of this study, (3) outlined the theoretical foundation of the study, and (4) provided a glossary of key terms.

Chapter 2 begins with a discussion of network analysis. This is followed with discussions of three broad topics: (1) structural holes, (2) Simmelian ties and network closure, and (3) task interdependence, and reviews the hypotheses to be tested. The research model is presented.

Chapter 3 presents the research design and methodology used in this study. The chapter provides details on the construction of the study sample and the survey instruments and measures used.

Chapter 4 describes the data analysis techniques used to test the hypotheses, contains the analysis of the measures used, presents descriptive statistics and correlations, and sets forth the results found.

Chapter 5 describes the theoretical and practical implications for the results obtained, and the limitations to the conclusions drawn. Suggestions for future research are given.

## CHAPTER 2

### REVIEW OF THE LITERATURE

#### Introduction

This chapter presents an extensive review of the literature pertaining to this study. Because some readers may be unfamiliar with aspects of social network analysis, an overview of important network analysis concepts and terms will be presented before reviewing the theoretical constructs. Following a presentation of the research model, the key constructs will be reviewed. Burt's (1992) structural hole theory and its relationship with effectiveness will be examined, followed by a presentation of the theory underlying Krackhardt's (1996) notion of Simmelian ties and the benefits of network closure. Finally, the theoretical justification for task interdependence as a moderator of the relationship between the independent variables and effectiveness will be presented. Hypotheses will be stated as the theoretical foundation for each is presented, and will be summarized at the end of this chapter.

#### Social Network Analysis

The term "network" has been used to describe quite varied phenomena, ranging from a person's individual contacts (Baker, 1992) to the structure of Japan's *Keiretsu*, the networks of closely-tied firms that characterize much of Japanese industry (Gerlach & Lincoln, 1992). The network perspective is a valuable and increasingly useful way to approach the study of organizations and organizational behavior, with the potential to reinvigorate and reshape much of organization science (Nohria, 1992). By focusing on

actors' relations and structural positions in addition to their attributes, researchers can better understand and predict behavior. For example, a study by Davis (1991) found that adoption of takeover protection mechanisms by Fortune 500 firms could be explained better by the social structures of the firms' boards than by the incentive-oriented predictions of agency theory. In a study within a Fortune 500 firm, Burt (1992) found that managers who are connected to others who are not themselves connected or well-organized, have faster promotion rates. In a small entrepreneurial firm, Krackhardt (1990) found that employees who held a more accurate cognitive map of the advice network (who goes to who for advice) were rated as more powerful by the employees in the firm. Thus, in a variety of settings, network analysis and theories have been found to generate useful predictions of behavior and outcomes. The development of social network analysis and its basic methods and concepts will be reviewed in the following paragraphs.

### The Development of Social Network Analysis

Scott (1991) traces the origins of social network analysis to the work of two distinct groups of researchers. The first group consisted of several leading gestalt-researchers who fled Germany in the 1930's: Jacob Moreno, Fritz Heider, and Kurt Lewin. Their focus on the structure of organized thought patterns led them to the study of structural patterns in informal relations. Moreno (1934) approached this work by mapping definite structures using what he called "sociograms," a visual representation of social structure using lines, dots, and arrows. Sociometry, as the analysis came to be called, still underlies much social network methodology.

The second group, also working in the 1930's, was the Hawthorne research team. Recognizing the importance of informal organizations to understanding the results of the experiments, the researchers used sociograms to represent the informal relations in the bank wiring room (Roethlisberger & Dickson, 1939), though there is no direct evidence that the Hawthorne researchers were aware of Moreno's work (Scott, 1991).

Though the Hawthorne experiments contributed to the understanding of informal groups, the researchers did not go beyond a description of the social networks, as they had no theory about how such networks might shape behavior. Still, their influence on Chester Barnard, part of the Harvard Circle along with Mayo et al. (Scott, W.G., 1992), and his conception of informal organizations is clear. For example, in *Functions*, Barnard (1938) defined an informal organization as "the aggregate of the personal contacts and interactions and the associated groupings of people . . ." (p. 115). For Barnard, the informal organization is a "shapeless mass of quite varied densities (clusters or cliques in network analysis), the variations in density being a result of external factors affecting the closeness of people geographically or of formal purposes" (p. 115). He recognized that informal organizations result from the repetitive and habitual interaction between persons, growing and developing without planning (Wolf, 1974).

Yet, despite Moreno's sociograms, Barnard's theorizing about informal organizations, and Roethlisberger's reporting of their importance in the Hawthorne experiments, the structure of informal relations remained largely outside the realm of rigorous analysis. No tools were available to carry discussions beyond the abstract and conceptual. In recent decades, however, sociologists and anthropologists have developed



theory and tools enabling the study of informal organizations as social networks. The methodological work of White and his Harvard graduate students in the late 1960's and early 1970's, publication of Granovetter's seminal article on "weak ties" in 1973, and the development of computer-based analytic tools sped the emergence of social network analysis as a legitimate scientific specialty encompassing work in anthropology, sociology, biology, and organizations (Hummon & Carley, 1993).

The social network perspective encompasses theories, models, and assumptions that are based on relational concepts (Wasserman & Faust, 1994). Network analytic techniques provided the first rigorous, theoretically grounded definitions for many social concepts that previously had intuitive or ambiguous definitions. For example, the concept of the Simmelian tie is given a mathematically-based definition by social network analysis, that of co-clique membership (Krackhardt, 1996). Though an informal definition of a clique might be any small exclusive group, in formal network analysis, a clique is a sub-set of actors in the network in which every possible pair of actors is connected and the clique is not contained in any other clique. Further, co-clique membership is defined as the number of times a pair of actors are in the same clique. By formalizing important relational concepts, social network methods enable theory development and testing. Though not restricted to the study of emergent structures, social network methods have been widely used to study such structures (e.g., Cook & Emerson, 1978; Brass, 1984; Krackhardt & Stern, 1988).

## Social Network Methods

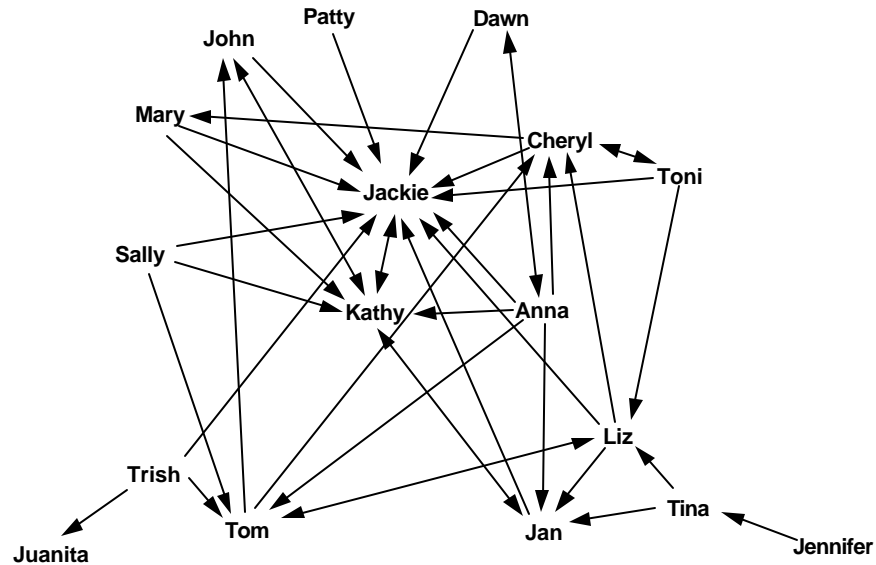
### Describing Relational Data

The following section serves as a brief introduction to key terms and concepts. Like all academic disciplines, social network analysis has its own vocabulary, which has been italicized in the following paragraphs.

Social network methods enable us to study the structure of relations between people, organizations, communities, nations, etc. Though in most research the relations studied have been social relations, the methods can be applied to economic and intellectual exchanges as well. The methods allow the analysis of both *whole* networks, which describe the entire structure of relations within a defined group such as a market, a firm, or a department, and *egocentric* (or *ego*) networks, such as one's network of friends or a firm's network of vendors.

Figure 2 illustrates an actual whole network using data collected by the author in an unpublished pilot project. The figure maps the network of trust relations among all employees of a small consulting firm. Using a typical survey instrument, the respondents were asked to list those in the firm “whom you would trust to keep in confidence your concerns about a work-related issue? . . . That is, if you had a sensitive or political problem at work, with whom would you be comfortable sharing your thoughts?” The nature of the relation was defined differently in this study; this data is used only to illustrate key concepts in social network analysis.

Figure 2  
A Trust Network in a Small Consulting Firm



At the time the data were collected, there were 17 employees in the firm. Because the mathematical approach of social network analysis is grounded in graph theory, networks are often described using the language of graph theory. Thus, the 17 *actors* are depicted as *points* in the sociogram, or *graph*, and the *relations*, or *ties*, among them are depicted as *lines*. The relations can be *directional* or *nondirectional*, and they can be *valued* or *dichotomous*. In Figure 2, the relations are directional, indicated by the arrows. So we know that in this trust network, for example, Tom would trust John with a politically sensitive issue, but that trust is not reciprocated by John. Thus, Figure 2 is a *directed graph*. Further, the relations in Figure 2 are dichotomous, in that a relation is present or it is not present. If the respondents had been asked to indicate the degree to

which they trusted each person named, the graph would contain valued data and different types of lines could be used to depict the different values of the relations. When the data are valued, the graph would be a *valued graph*. It follows that directional and valued data are described in a *valued directed graph*.

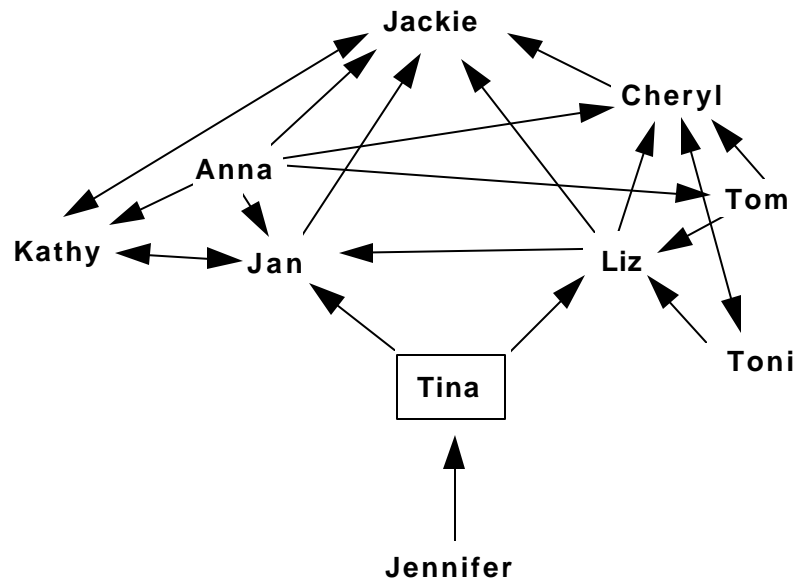
When undertaking any network study, it is important to remember that the computer algorithms used to calculate network measures are often limited in the type of information that can be calculated. Many of the most common network measures are limited to undirected and dichotomous data. These limitations can make the study of inherently directed relations more difficult and can force the analyst to lose important information by converting valued data to dichotomous data.

Figure 3 is an example of an egocentric network. Based on the data from the graph in Figure 2, only Tina's network of *primary* and *secondary* trust relationships is shown. Tina has three primary relationships: she is trusted by Jennifer and trusts Jan and Liz; and seven secondary relationships: Jennifer, Jan, and Liz are themselves connected to a total of seven other persons. As is evident from the graph, in considering an ego network, the analyst has to decide how many levels of contacts to include. If we included Tina's tertiary contacts in her network, Tina's network would include nearly everyone in the firm. Typically, analyses of ego networks are limited to relations among an actor's primary and secondary contacts.

Sociograms indicate the structure of relations, but not their content. The lines could depict friendship, exchanges of goods or skills, trust, and so on. Sociograms can

carry a great deal of information about relational structure and the visual depiction of the relations enables one to grasp quickly the basic structure of the network in question.

Figure 3  
An Egocentric Network



In order to ease the construction of consistent sociograms, researchers have developed computer programs that model the relations using multi-dimensional scaling (MDS) techniques. Figure 2 was drawn using an MDS routine, though it has been modified slightly for clarity.

As the pattern of relations becomes more complex due to the addition of actors and relations, the sociogram can become unwieldy in its complexity. A network with only 20 actors could have as many as 380 ties ( $n \times n-1$ ) of varying intensities and directions; one with 40 actors could have nearly 1,600 ties! A complex sociogram can quickly become hopelessly chaotic. Additionally, a sociogram is a valuable tool for depicting relational structure, but not for analyzing it. Analysis requires quantified

measures that can be compared, correlated, and otherwise manipulated. For example, glancing at a sociogram can give one a sense of the network's *density*, the ratio of actual ties to possible ties, but to go further a density measure is needed.

Thus, the relational structure is typically captured in a matrix, which opens the door to virtually unlimited mathematical operation and the adoption of conventions that ease discussion. The presence of a relation is the raw material for the network matrix. For example, a dichotomous relation is captured in binary form -- "1" indicates the presence of a relation, "0" indicates its absence.

There are two types of matrices, rectangular and square, and each has its use in network analysis. The rectangular matrix, known as an *incidence* matrix, is used to depict relations of actors to events or affiliations. By convention, the rows indicate the actors and the columns indicate the events or affiliations to which the components belong. For example, the rows might be the 17 employees in the consulting firm and the columns might be the professional associations to which employees might belong.

The square matrix is termed an *adjacency matrix*. The adjacency matrix puts the actors in the rows and in the columns. In the row, the actor is a sender of the relation; in the columns, the actor is a receiver of the relation. Figure 4 is the adjacency matrix underlying the graph depicted in Figure 2. Thus, by looking at the matrix, it can be observed that Sally trusts Tom, Kathy, and Jackie, while Sally herself is trusted by no one. Since the actors occupy both the rows and the columns, the diagonal becomes meaningless. Further, in an undirected graph, the areas above and below the diagonal are symmetrical. Finally, had the respondents been asked to value the strength of their trust

on a 5-point scale, then the cells off the diagonal would have a value of 0 to 5, with 0 indicating the absence of a relation and the values of 1 to 5 indicating the strength of their trust.

Figure 4  
The Adjacency Matrix Underlying the Graph Depicted in Figure 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<b>1. Sally</b>	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>2. Tom</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
<b>3. Kathy</b>	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1
<b>4. Jan</b>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>5. Juanita</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>6. Trish</b>	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
<b>7. Jennifer</b>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<b>8. Mary</b>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>9. Tina</b>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>10. John</b>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>11. Patty</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>12. Anna</b>	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1
<b>13. Dawn</b>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
<b>14. Cheryl</b>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
<b>15. Liz</b>	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1
<b>16. Toni</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
<b>17. Jackie</b>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

### Network Measures

Numerous advances in the analysis of these matrices have been made in the last fifteen years. Network analysis programs, such as UCINET V (Borgatti, Everett, & Freeman, 1992), which will be used for this study, are collections of algorithms that utilize matrix operations and graph theory to create useful network measures.

As discussed, relational ties can be measured for their presence, direction, reciprocity, value, and density. Another key set of measures has to do with the centrality of an actor in the network. Though Figure 2 clearly shows that Jackie plays some sort of central role in the trust network, centrality can take several forms. The three most common measures of centrality are degree, closeness, and betweenness (Freeman, 1979). Degree is the simplest and comes in two forms: *outdegree* and *indegree*. Calculating degree is a matter simply of counting the number of directional ties. In Figure 4, Kathy is the sender of three trust ties and the receiver of six; she trusts three people and six people trust her. Thus, Kathy has an outdegree of 3 and an indegree of 6. Degree is a somewhat crude, but often useful, measure.

The *closeness* measure accounts for both direct and indirect links and conceptually represents ease of access to others, which one would expect to vary among the actors. Not surprisingly, Jackie has the highest closeness score in Figure 2, though because the calculation of closeness requires symmetrical data, the algorithm assumes that all ties are reciprocal, introducing the difficulties noted earlier. *Betweenness* measures the extent to which an actor lies on the shortest paths between other actors, perhaps by connecting clusters, or *cliques*, of the other actors. High betweenness centrality implies the actor is in a position to act as a boundary-spanner because that actor is connected to otherwise disconnected parts of the network. There are other measures of an actor's centrality, all of which are distinct, though complementary, in their theoretical orientation (Brass, 1992).



A second set of measures is the identification of subgroups within the network, commonly referred to as clusters or cliques. Techniques are available to identify densely-connected cliques within the fabric of the network.

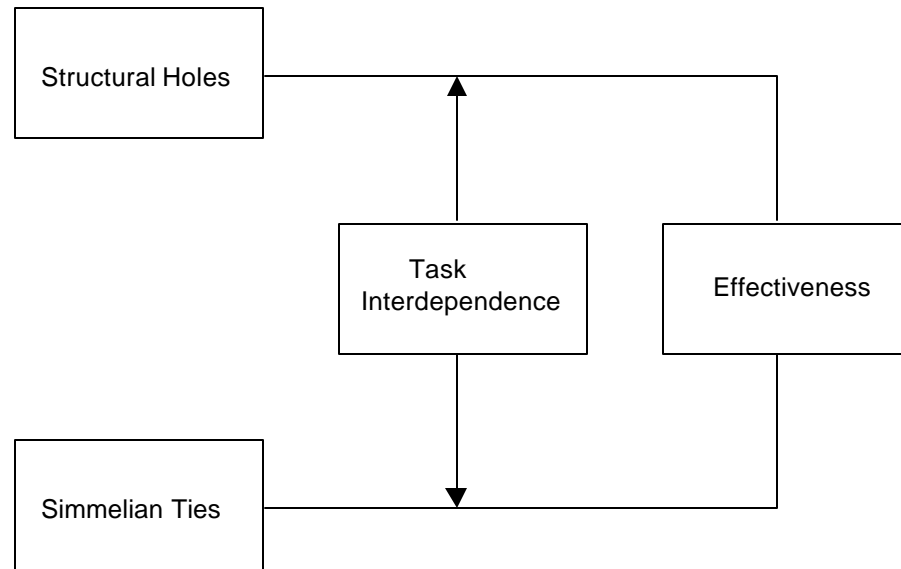
A third set of measures focuses on the structural equivalence of the actors in the network. Actors who occupy similar structural positions in the network by being connected to the same people are structurally equivalent. The measurement of structural equivalence has benefited from the development of clustering techniques that enable the reduction of matrices to simpler representations, revealing underlying patterns of relations.

### The Research Model

As noted earlier, the use of social network analysis is relatively new in organizational research. Thus, the preceding introduction to network analysis was provided in order to familiarize readers with key terms and concepts that are important to the presentation of the research model underlying this study. Similarly, the following section presents an overview of the research model in order to orient the reader to the theoretical development that follows.

As previewed in Chapter 1, the purpose of this research is to examine whether there are main and moderated effects of structural holes and Simmelian ties on individual effectiveness, with task interdependence as the moderating variable. The theoretical model for this study is presented in Figure 5. The variables and relationships depicted in the model will be discussed in the following sections of this chapter, along with previous research and the rationale on which the model is based.

Figure 5  
Theoretical Model



The next section will present the development of Burt's structural hole theory and the proposed relationship with effectiveness. Following this, the theoretical development of Simmelian ties will be presented, as well as a discussion of the role of task interdependence as a possible moderating variable.

### Structural Holes

In his book, *Structural Holes*, Burt (1992) proposes a theory of competition, which holds that competitive advantage is a function of the social structure in which the actor (individual, firm, industry) operates. Burt's theory of structural holes provides a theoretical basis for operationalizing the notion of structure, which is valuable in a competitive, as opposed to a cooperative, arena. In the following sections, the theoretical and empirical foundations of structural hole theory will first be reviewed, followed by an

explication of the theory, and, finally, a review of recent empirical work incorporating the structural hole perspective.

### The Development of Structural Hole Theory

Burt's (1992) theory of structural holes is based on several streams of sociological theory: Granovetter's (1973, 1982) work on the role of weak ties in the social structure, Cook and Emerson's (1978) work on the value of exclusive exchange partners, and the benefits of betweenness centrality (Freeman, 1977, 1979). The following sections will review each.

#### Weak Ties

There is probably no network paper more cited than Granovetter's (1973), "The Strength of Weak Ties." For his doctoral dissertation, Granovetter examined the effect of social structure on getting a job. Surprisingly, he found that people almost never found jobs through their close contacts. Instead, the jobs nearly always originated through a distant contact to whom the job-seeker was only weakly tied. Building on the earlier work of Homans (1950) and Festinger, Schacter, and Back (1950) into the movement of information within cohesive groups sharing strong ties, Granovetter theorized that because in cliques of strong relations everyone soon learns of any new information in the group and because persons in such cliques tend to be similar (Berscheid & Walster, 1969; Newcombe, 1961), new valuable information is most likely to come from outside one's immediate cluster of strong ties; that is, from the non-redundant weak ties, which serve to bridge clusters of strong relations. In Granovetter's formulation, the strength of a tie is a

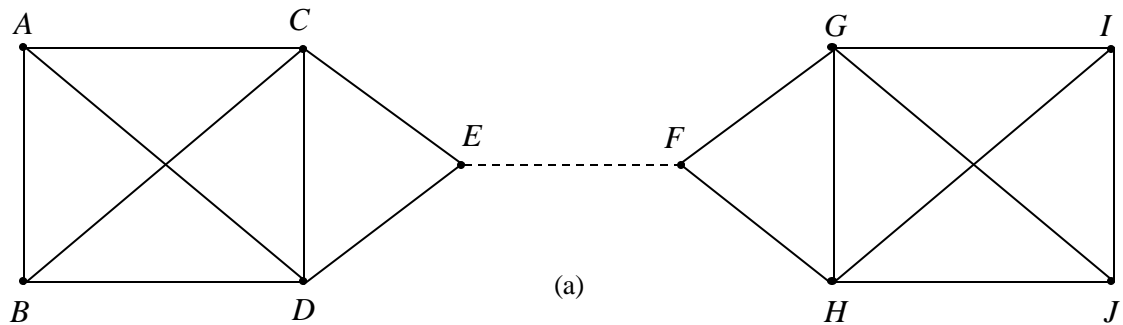
combination of the amount of time, the emotional intensity, the intimacy, and the reciprocal services that characterize the relationship.

Admittedly an exaggeration made to illustrate his point, Granovetter (1973) referred to the open triad illustrated in Figure 1 as the “forbidden” triad when the ties A-B and A-C are strong ties. In Granovetter’s exaggeration, the open triad in Figure 1 could not exist (thus, it is forbidden), because whenever two actors are each strongly tied to a third actor, then they will necessarily be strongly tied to one another as well. In network analysis, a relation is said to be transitive when the relation holds between every pair of successive actors in a sequence and it holds for any two actors. In other words, if A “chooses” B as a friend, A “chooses” C as a friend, and B “chooses” C as a friend, then friendship is a transitive relation. The extreme of Granovetter’s thesis is that transitivity will hold in all strong tie relations. Thus, for Granovetter, the open triad in Figure 1 could not exist, since B and C would necessarily be strongly tied if the strong relations are transitive. Thus, since transitivity does not hold for the open triad in Figure 1, Granovetter called it the forbidden triad for rhetorical purposes. For Granovetter, if A is strongly tied to B and A is strongly tied to C, then B necessarily will be strongly tied to C.

A bridge in a network is a tie that provides the only path between two points. To the extent that these forbidden triads are actually absent from a network, all bridges in the network are necessarily weak ties, as will be illustrated in Figure 6. Note that this does not imply that all weak ties are bridges, but simply that all bridges are weak ties.

The solid lines in Figure 6 represent strong ties and the dashed line represents a weak tie. In the formulation of the forbidden triad, the tie E-F is necessarily a weak tie in that it is the only path between E and F. If E was strongly tied to G or H, or F was strongly tied to C or D, then, the tie between E and F would be a strong tie if the forbidden triad thesis holds.

Figure 6  
A Network Bridge



This prediction of transitivity is fundamental to Granovetter's argument that weak ties lead to new and valuable information while strong ties lead to redundant and, hence, less valuable, information, because only weak ties serve as bridges to distant cliques of strong ties. It has been shown that strong ties are transitive with a greater probability than one would expect from a null model (Davis, 1979). Nonetheless, transitivity does not hold in all cases, not even 50% of the time (Krackhardt, 1996), and in some cases, much less (Robinson & Balkwell, 1995). Still, empirical studies based on Granovetter's weak ties hypothesis have found evidence that bridges between cliques of strong ties do tend to be weak ties and that valuable information benefits can result from weak tie structures.

In a study of relationships among faculty at a university, Friedkin (1981) found that of 11 local bridges tying together otherwise disconnected cliques, all the bridges were weak ties. Similarly, in a network study of 280 members of an Israeli kibbutz, Weiman (1980, in Granovetter, 1982) found that weak ties bridged the cliques of strong ties. On the issue of transitivity, Weiman found that networks of strong ties tend toward transitivity, while weak ties do not. Given the role of weak ties in bridging cliques of strong ties, the results of a study by Lin, Eisel, and Vaughn (1981) are not surprising. In a study of working males, these researchers found that the use of weak ties in job searches has a strong association with success when the weak ties lead to someone who is well placed in the occupational structure. These results are consistent with the earlier findings of Granovetter (1973).

The usefulness of weak ties in non-job search environments has been demonstrated by several recent studies. In a study of the problem-solving networks in a large hospital, Stevenson and Gilley (1993) found that managerial networks of weak ties are used for problem-solving, particularly for equivocal problems. In a study of 115 employees of a large telecommunications firm, Hinds and Kiesler (1995) found that the administrators use weak ties to gain resources unavailable from local resources. Similarly, in a study of 160 employees of a global computer manufacturer, Constant, Sproull, and Kiesler (1996) found that those who need information use electronic weak ties to gather valuable technical advice from others. These studies confirm Granovetter's initial proposition that weak ties serve to bridge cliques of strong ties and are an

important source of new and valuable information. Table 1 summarizes these weak ties studies.

Table 1  
Summary of Weak Tie Studies

Source	Findings
Friedkin (1981)	Weak ties serve as bridges.
Lin, Ensel, and Vaughn (1981)	Weak ties are an important source of information.
Weimann (1980, in Granovetter, 1982)	Strong ties tend toward transitivity, weak ties do not. Weak ties bridge cliques of strong ties.
Stevenson & Gilley (1993)	Weak ties are an important source of information.
Hinds & Kiesler (1995)	Weak ties are an important source of information.
Constant, Sproull, & Kiesler (1996)	Weak ties are an important source of information.

To reiterate, the central thesis of the weak ties argument is that new and valuable information is most likely to flow to an actor across a weak tie, which serves as a bridge linking the actor to disparate clusters of strongly tied others. As will be seen, this argument is fundamental to structural hole theory.

### Exchange Networks

An exchange relation is any relation in which there is a transfer of valued items, whether tangible, such as goods, or intangible, such as affection. The social exchange theoretical formulations of Thibaut and Kelley (1959), Homans (1961, 1974), and Blau (1964) largely focused on the dyadic elements of larger social structures (Yamagishi, Gillmore, & Cook, 1988). Laboratory studies developed by Emerson and associates (Emerson, 1972; Cook and Emerson, 1978; Cook, Emerson, Gillmore, & Yamagishi,

1983) in the 1970's shifted the focus from the dyad to more complex structures, which were labeled exchange networks. The exchange network perspective holds that power cannot be studied meaningfully in the dyad; that power is strongly influenced by larger social structures. Thus, these theorists directed their efforts at predicting the distribution of power based on the structural characteristics of exchange networks.

As originally formulated by Cook et al. (1983), an exchange network is a social structure consisting of three or more actors in which there are at least two "network connections." The mere fact that two exchange relations share a relation with a common third does not necessarily constitute a network. The fact that A-B and B-C have exchange relations does not necessarily mean that A-B-C is an exchange network. The three actors constitute an exchange network only when the exchange relation A-B affects the exchange relation B-C and vice versa. Further, the connection is positive when one exchange relation facilitates exchange in the other relation and negative when one exchange relation diminishes exchange in the other relation (Cook & Emerson, 1978; Yamagishi, Gillmore, & Cook, 1988). Negative connection in A-B-C creates competition, as when B has a limited supply of goods for which both A and C compete. Conversely, positive connection promotes flow, as when B acquires a resource from A and passes it on to C; thus, vertical integration is an example of positive connection.

Power in exchange networks is created by the control of scarce resources, illuminating the understanding that the nature of the exchange relations influences power, not simply the structure of those relations (Brass, 1992). This resource dependence view of exchange in social networks has been largely supported in laboratory studies (Cook &



Emerson, 1978; Cook et al, 1983; Yamagishi, Gillmore, & Cook, 1988; Markovsky, Willer, & Patton, 1988; Stolte & Emerson, 1977) and studies of markets (Burt, 1980, 1983).

The laboratory studies of exchange networks were first formulated by Cook and Emerson (1988). In a laboratory simulation of four-person exchange networks based on negotiated trade agreements, the researchers found that, consistent with the theoretical formulations outlined above, power is an attribute of position in the network structure observable in the actor's behavior. In these studies, power accrued to those subjects who were connected to others who themselves were disconnected. In follow-on studies by Cook et al. (1983), the researchers conducted both laboratory studies and computer simulations of resource dependence hypotheses in exchange networks. Consistent with the earlier findings, the researchers found that power flowed to those positions that have greater access to resources (more paths to others). Additionally, these studies demonstrated that resource-dependence can be a better prediction of power than can some centrality measures, which fail to take into account all direct and indirect paths in the network. These findings were further supported in laboratory studies of five-person networks conducted by Yamagishi, Gillmore, and Cook (1988) and in small-group laboratory simulations by Markovsky et al (1988). Table 2 summarizes these exchange network studies.

With respect to structural hole theory, the central finding of the exchange studies is that power (or higher profits) accrues to those actors who enjoy exclusive relations with others who are themselves disconnected (Burt, 1992, 1997a).

Table 2  
Studies of Exchange Networks

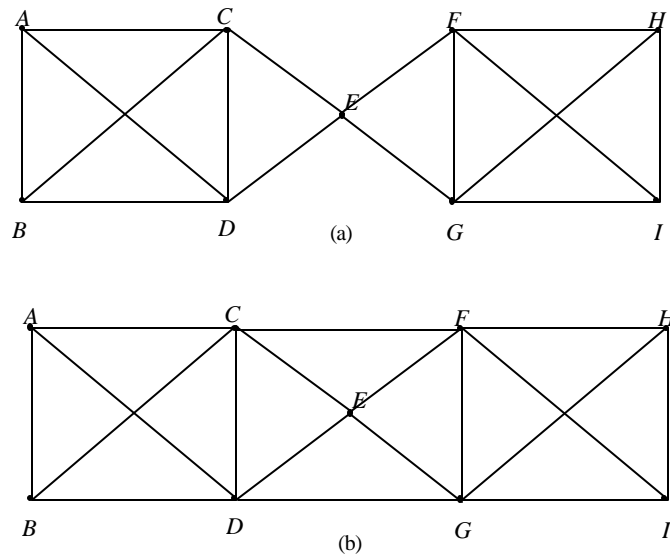
Source	Findings
Cook & Emerson (1978)	Resource-dependence hypotheses on the value of being exclusively connected to disconnected others supported.
Cook et al (1983)	Resource-dependence hypotheses on the value of being exclusively connected to disconnected others supported.
Yamagishi, Gillmore, & Cook (1988)	Resource-dependence hypotheses on the value of being exclusively connected to disconnected others supported.
Markovsky, Willer, & Patton (1988)	Resource-dependence hypotheses on the value of being exclusively connected to disconnected others supported.

### Betweenness Centrality

The third research stream foundational to structural hole theory focuses on the benefits of high betweenness centrality. Betweenness is one aspect of an actor's centrality in the network and measures the extent to which the actor lies on the shortest path, referred to as a geodesic in network analysis, between pairs of other actors. The greater the extent to which actors in the network must go through the focal actor to reach others in the network, the higher the focal actor's betweenness centrality. If Figure 7a is taken to be a sociogram of reciprocal trust relations, then actor E is seemingly well-positioned to act both as a gatekeeper of important information between the two cliques and to promote cooperation between the groups, for actor E is the only actor with primary trust links into both groups. However, in Figure 7b, the addition of the paths C-F and D-G dramatically reduces the structural benefits for actor E. No longer is actor E the only path along which valuable and reliable information can flow. No longer can only E bring

the two cliques together. While the most naive observer would recognize the implication of the added paths, this loss of benefit can be described by the network analyst as a decrease in betweenness centrality.

Figure 7  
Betweenness Centrality



Several early centrality researchers recognized the strategic importance of actors' locations on geodesics and the implications for network control (Bavelas, 1948; Cohn and Marriott; 1958; Shaw, 1954; Shimbel, 1953). Freeman's (1979) widely-adopted conception of betweenness centrality is focused on the extent to which the focal actor has control over others; it represents the possibility of increasing the dependence of others on the focal actor (Brass, 1992; Brass & Burkhardt, 1993). Freeman further suggests that betweenness centrality is particularly appropriate for measuring the control of information, in that the mediating actor may withhold or distort information that is passed on. The intuitive appeal of betweenness centrality as a correlate of network control has

been borne out in most network studies that examine betweenness centrality as a predictor of power, influence, and other desirable outcomes in the network.

In studies of 140 full-time, non-supervisory employees of a large newspaper, Brass (1984) and Brass and Burkhardt (1992) found that betweenness centrality in the workgroup, the department, and the organizational networks were all significantly correlated with influence in the organization. Interestingly, in a study of 75 employees of a federal agency, the same researchers (Brass & Burkhardt, 1993) found that betweenness centrality was not an independent predictor of power in the organization. In a study of 36 employees of a small high-tech firm, Krackhardt (1992) found that betweenness centrality was significantly correlated to respondents' perceptions of the social networks (i.e, those with higher betweenness centrality had a more accurate understanding of the organizational social networks). Such knowledge has been found to be a significant predictor of reputational power (Krackhardt, 1990). In a meta-analysis of eight communication network studies exploring the relationship of betweenness centrality with key outcomes, Mullen et al. (1991) found that betweenness centrality is a significant predictor of leadership, satisfaction, and participation. Table 3 summarizes these centrality studies.

As noted earlier, Burt's (1992) theory of structural holes is based on several streams of sociological theory. Granovetter's (1973, 1982) work on the role of weak ties in the social structure, provides substantial insights into the ways in which weak ties can generate new and valuable information for actors. Cook and Emerson's (1978) work on exchange theory demonstrates that power accrues to actors who enjoy exclusive

exchange relationships. Finally, the benefits of betweenness centrality (Freeman, 1977, 1979) provide substantial network control for the focal actor. The following section will review the further refinement of these concepts in Burt's (1992) theory of structural holes.

Table 3  
Betweenness Centrality Studies

Source	Findings
Brass (1984) Brass & Burkhardt (1992)	Betweenness centrality hypothesis supported.
Brass & Burkhardt (1993)	Betweenness centrality hypothesis not supported.
Krackhardt (1992)	Betweenness centrality was significantly correlated to respondents' perceptions of the social networks. In an earlier study using the same data, these perceptions were found to be significantly related to reputational power (Krackhardt, 1990).
Mullen et al (1991)	Betweenness centrality in communications is a significant predictor of leadership, satisfaction, and participation.

### Structural Hole Theory

In his theory of structural holes, Burt (1992) combines the information benefits of weak-ties, the power effects of favorable network exchange positions, and the network control afforded by betweenness centrality to create a structural theory of competitive advantage. In Burt's conception, personal networks optimized for structural holes create information and control benefits for the actor, which result in favorable performance outcomes. The following paragraphs present a thorough explication of structural hole theory.

## Social Capital

Burt (1992) notes that an actor brings at least three kinds of capital to the competitive arena. First, the actor brings financial capital: cash, borrowing capacity, etc. The actor also brings human capital to the arena: intelligence, common sense, wisdom, charisma, etc. Finally, the actor brings social capital: relationships with other actors, such as friends, colleagues, business acquaintances, and so on. The actor has close relationships with some of these contacts and distant relationships with others. Further, the actor's direct contacts have contacts of their own, which can be considered the actor's extended network of contacts.

For Burt (1992), financial and human capital are distinguished from social capital in several ways. First, financial and human capital are owned by individuals, whether actual persons or corporate persons, whereas social capital is owned by the parties to the relationship. Second, financial and human capital are concerned with production factors in that they are used to create production capability. Actors build plants, get educations, develop training programs – all of which are investments of financial and human capital made with the prospect of generating a return. Conversely, social capital is not concerned with the investment side of the equation, but with the rate of return portion of the equation (i.e., social capital, the actor's network of contacts, determines how the actor's production capabilities will be used). For example, an investment in a Ph.D. is only as valuable as the opportunities available to use the skills and training. Burt argues that networks of personal contacts determine the opportunities to earn a return and, hence, constitute social capital.

Further, social capital necessarily becomes more valuable as competition becomes more imperfect and investment capital becomes more abundant (Burt, 1992). Perfect competition reduces the rate of return, and hence the value of social capital, to a constant as investment moves freely from lower-yielding to higher-yielding investments. In a perfect market, all buyers and sellers have equal access to one another – social capital plays no role and has no value. Conversely, when ample investment dollars chase a few investment opportunities, the winners will likely be those investors who know someone. Of course, in the “real world,” competition is always imperfect and often remarkably so; likewise, there are typically abundant financial and human capital chasing opportunities. Thus, in most arenas, social capital is a valuable resource.

#### The Benefits of a Well-structured Network

Burt (1992) proposes that a well-structured personal (egocentric) network is one that creates competitive advantage for the actor by providing two sets of benefits to the actor: information benefits and control benefits. Each will be explored in the following paragraphs.

In Burt’s (1992) theory, there are three forms of information benefits: access, timing, and referrals. Access refers to receiving a valuable piece of information and knowing who can use it. Timing simply refers to being informed early. Referrals speak to information about the actor that flows back out to the network. Referrals not only get the actor’s name mentioned in the right place at the right time, but also legitimizes the actor’s interest in the opportunity by enabling the actor’s interest to be manifested through a “disinterested” third party.

Thus, a personal network rich in information benefits for the actor would have contacts in places where useful information is likely to surface and provide a reliable and timely information flow to and from those places. Selecting contacts for the network is especially important to the issue of reliability. Every actor selects contacts to serve as the basis for the actor's network and the value of the network is enhanced to the extent the actor can trust those contacts to pass on valuable information promptly.

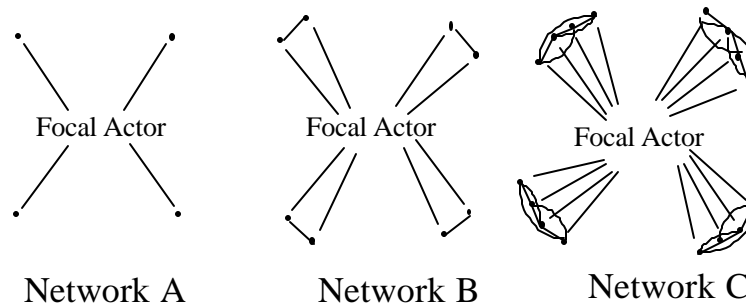
In addition to developing a set of reliable contacts, the actor wishing to build a competitively advantageous network must have contacts in places where useful information is likely to be found. All else held constant, a large and diverse network of non-redundant contacts is likely to yield more information benefits -- more exposure to valuable information, earlier exposure, and more referrals. Contacts can be redundant for two reasons. First, there may be a direct tie between them, which is referred to as "cohesion." The stronger the direct tie, the greater the cohesion and, by extension, the redundancy of the contacts. With respect to the tie between them, close friends are more redundant than are casual acquaintances; in other words, cohesion is greater between the friends than between the acquaintances. Even if there is no direct tie, contacts can still be redundant because they share mutual contacts. The greater the number of mutual contacts, the greater the redundancy. In network language, the sharing of mutual contacts is referred to as "structural equivalence."

If there was unlimited capacity to maintain contacts, the distinction between redundant and non-redundant contacts would be unimportant. The actor would maintain



a relationship with all others in the relevant network. However, there is a limit to the number of contacts a single actor can maintain. Figure 8 illustrates the problem.

Figure 8  
Network Redundancy  
Burt (1992), Figure 1.1, p. 17



Network A has four non-redundant contacts that must be maintained. Network B has eight contacts to be maintained, but adds no non-redundant contacts. The contacts in each pair share a close tie and each contact will tend to know what the other contact knows. Network C compounds the problem further; there are 16 direct contacts but the network still provides only four non-redundant contacts. In other words, Network C requires more work (investment of time to maintain the contacts) with no incremental information benefits for the focal actor.

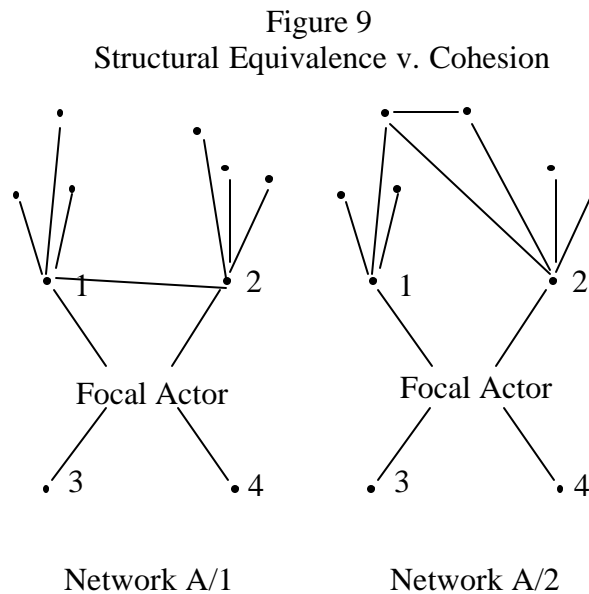
Burt (1992) has coined the phrase, “structural holes,” to describe the space between non-redundant contacts. Non-redundant contacts are connected by a structural hole. Network A has four non-redundant contacts and four structural holes. Despite having eight contacts, Network B has only four non-redundant contacts and four

structural holes. Network C has 16 contacts, but still only four non-redundant contacts and four structural holes.

Structural holes are not all or nothing features of a network. There are “large/deep” holes and “small/shallow holes” -- based on the degree of non-redundancy. As noted earlier, contacts can be redundant for two reasons: they can be cohesive (more or less so) or they can be structurally equivalent (more or less so), or some combination of both. Cohesiveness implies some kind of direct tie between the contacts; the stronger the direct tie, the greater the cohesion and, by extension, the redundancy, and the shallower the structural hole. In Burt’s parlance, the structural hole is shallower between the friends than it is between the acquaintances. In Network A/1 in Figure 9, contacts 1 and 2 are redundant by cohesion; the degree of the redundancy is a function of the strength of the tie. Similarly, contacts can be redundant because they are to some degree structurally equivalent, i.e., they share mutual contacts. The greater the number of mutual contacts, the greater the redundancy, and the shallower the hole. In Network A/2 in Figure 9, contacts 1 and 2 are somewhat redundant because they are to some degree structurally equivalent.

To reiterate, in Network A in Figure 8 the holes are as deep as they get -- complete non-redundancy; there are no ties between the sets of actors/pairs/clusters and no contacts are shared outside the pairs or clusters. But in Network A/2 in Figure 9, contacts 1 and 2 are no longer completely non-redundant; the structural hole between them has shrunk -- it is a shallower hole. In network terms, nodes 1 and 2 lack cohesion (they have no direct tie) but are somewhat structurally equivalent, in that they are

indirectly connected by mutual contacts. In Network A/1 in Figure 9, contacts 1 and 2 are redundant due to cohesion; they are connected to each other.

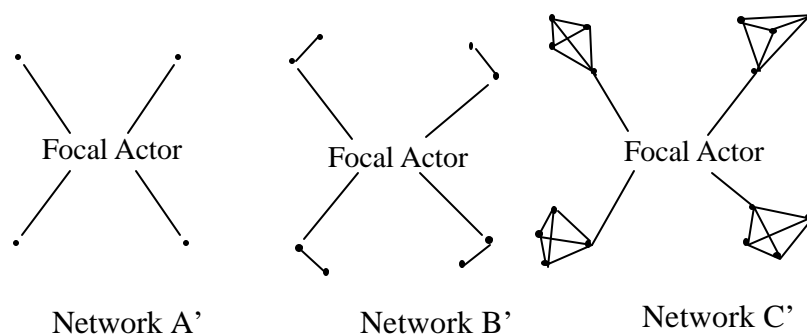


Burt (1992) points out that these indicators of redundancy, cohesion and structural equivalence, are neither independent nor absolute. Relations are only “strong” relative to other relations. Structural equivalence is rarely complete. Further, the two indicators are correlated. People who share common friends often develop a strong relationship themselves. In addition, Burt holds that cohesion is the more certain indicator. When two people share a strong tie, they are very likely to be redundant -- likely to communicate, have access to the same information, and share common contacts. It follows that redundancy is most likely between structurally equivalent people connected by a strong relationship.

For Burt (1992), the objective is to balance network size and diversity by optimizing structural holes. There are two design principles. The actor seeking a

competitive advantage should strive to build an *efficient* network by maximizing the yield of structural holes per contact, and an *effective* network by maximizing the total number of structural holes. Figure 10 will help to illustrate these principles.

Figure 10  
Network Efficiency  
Burt (1992), Figure 1.3, p. 20



Networks A (Figure 8) and A' (Figure 10) are identical. By pruning four primary contacts from B as in B', the actor has made B' more efficient than B (Figure 8) by increasing the average number of people reached with each primary contact. There are still only four non-redundant contacts, but the time required to maintain four non-redundant contacts has been halved by the elimination of the redundant contacts. The process is similar for networks C and C'. In C', the actor has pruned 12 primary contacts while not decreasing the number of structural holes; direct and indirect relations with 16 contacts are maintained while investing in only four direct contacts. Network C' is much more efficient than Network C (Burt, 1992).

Whereas efficiency is concerned with the number of contacts per primary contact, and is illustrated by comparing the networks in Figure 8 and Figure 10, effectiveness is

concerned with the yield of the whole network and can be thought of as moving from Network A' to Network B' to Network C' in Figure 10. Here, Burt (1992) suggests that each primary contact be thought of as a port to a larger cluster. The focal actor wants to maximize the total number of contacts reached by direct and indirect ties. Networks A' and C' both have four primary contacts and four structural holes, but Network C' has sixteen contacts compared to only four in Network A'.

Thus, Network C' is an example of an efficient and effective personal network that will provide substantial information benefits to the "owner" of the network. To build such a network, one would develop a handful of close, trusting ties to persons who do not know one another and who maintain large, diverse, non-overlapping networks of their own. The strong direct ties ensure that the focal actor learns of valuable information on a timely basis and benefits from valuable referrals to the secondary networks. By ensuring that the direct ties lack ties and mutual contacts with one another, the network is maximized for structural holes and, thus, information benefits (Burt, 1992).

Burt (1992) notes that structural holes in a personal network also offer control benefits. Burt's conception of the benefits that flow from being the *tertius gaudens* in a social triad, literally "the third who enjoys" (Simmel, 1950, p. 154), is derived from the work of Georg Simmel, the German sociologist. Simmel notes that there are two *tertius* strategies. The first strategy is that of being the third, the *tertius*, between two or more parties who are after the same relationship with the *tertius*, such as two vendors who are vying to make a sale to the same buyer or a valued employee who is considering several competing promotions offered by different department managers within a firm. This is a

very common situation and describes much of a market economy. The *tertius* can play one bid off against the others and is in the strongest bargaining position when the bidders have no relations among themselves. The *tertius*' bargaining position is weakened when the sellers can share information. For example, the seller of a product is advantaged when potential buyers cannot share information about the price quoted to each of them. Thus, to the extent that the sellers are separated by a structural hole the bargaining power of the *tertius* is strengthened.

The second strategy is more subtle. Here, the *tertius* hopes to exploit the conflicting demands of two players. For example, the *tertius* might be a highly skilled worker assigned to several work teams who has to reconcile (or more to the point, exploit) the conflicting demands of the team leaders. Whether the competition is explicit or created, the *tertius* is in a position to broker the tension in the triad.

For Burt (1992), structural holes are the “setting of *tertius* strategies” and “information is the substance” (p. 33). The structural hole between the other two players in the triad enables the *tertius* to move accurate, inaccurate, distorted, complete, or ambiguous information between them.

### Structural Holes and Individual Effectiveness

As reviewed earlier, much of the empirical support for the theorized effects of structural holes is derived principally from three research streams. First, Granovetter's (1982) weak ties argument provides the basis for the importance of non-redundant contacts in generating new and valuable information. Second, the power benefits of structural holes are demonstrated by the laboratory studies supporting the work of Cook

and Emerson (1978) on exchange theory. These studies have shown that valuable resources flow to actors who enjoy exclusive exchange relations with otherwise disconnected partners (i.e., partners separated by structural holes). Finally, previous studies (e.g. Brass & Burkhardt, 1993) on the importance of betweenness centrality in the creation of an actor's control, provide further support for the structural hole theory.

In his book, *Structural Holes*, Burt (1992) presents some of his initial research on the structural hole theory. In an archival study of twenty years of data from 77 product markets, Burt (1992) found that profit margins are eroded by structural holes around the producers and enhanced by structural holes around the customers. Thus, producers were able to exploit structural holes between customers, while the producers were not similarly susceptible. In a study of promotion rates of several thousand managers in a Fortune 500 firm, Burt (1992, 1997a, 1997b) found that the lack of structural holes in an actor's personal network was a significant predictor of delayed promotions for the actor, and that the relationship is especially strong for managers on what Burt calls "social frontiers" (Burt, 1992, p. 119), such as women and minorities for whom social contacts are especially important. Similarly, Sparrowe and Popierlarz (1995; as reported in Sparrowe & Liden, 1997) found that structural holes in the networks of hospitality industry managers significantly increased their promotion rates. Thus, it is hypothesized that:

H1: There is a positive relationship between structural holes and individual effectiveness.

### Closing the Triad: Simmelian Ties

In its simplest form, Burt's (1992) theory of structural holes is captured in the open triad in Figure 1. In this open triad, the focal actor maintains a strong tie to both contacts, who do not have a relationship between themselves; the triad is basically two dyads. The structural hole separating these non-redundant contacts creates information and control benefits for the focal actor. Thus, following Burt's structural strategy, the focal actor would build a personal network characterized by such open triads and the resulting structural holes.

Other theorists, however, notably James Coleman (1990) and Georg Simmel (1950), emphasize the benefits that derive from closing the triad, that is, from all three actors sharing strong ties, as illustrated by the closed triad in Figure 1. For Coleman and Simmel, there are significant personal benefits to be derived from closing the triad.

Coleman (1990) holds that closure of any social network, a triad or a much larger system, is very important to the emergence of norms in the group, such as a norm of cooperation; and to the development of trust, if trust is to reach a level warranted by the trustworthiness of the individuals in the network. Simmel (1950) focuses on the triad itself, which he distinguishes from dyads in several ways. Triads reduce individuality, individual power, and moderate conflict. For Simmel, the closing of the triad completely changes the nature of the relations in the dyads. In the following section, the benefits of network closure as theorized by Coleman and Simmel will be examined.



### The Emergence of Norms

In *Foundations of Social Theory*, Coleman (1990) examines the importance of network closure to the development of norms within a social structure. For Coleman, “. . . a norm concerning a particular action exists when the socially defined right to control the action is held not by the actor but by others” (p. 243). Norms can be enforced with either negative sanctions, in the case of proscriptive norms, or positive sanctions, in the case of prescriptive norms.

### The Demand for Norms

As Coleman (1990) notes, demands for norms in the social structure arise when several conditions are met. First, externalities must exist; an externality being an action that has consequences to a person or persons who have no control over the action. Second-hand smoke in the workplace is an example of an externality; there are consequences to non-smoking employees of being exposed to second-hand smoke, but they may have no control over the actions of smokers. If actions have no consequences for others, norms will not emerge.

A second condition is that it must be impractical to establish a market in the rights of control over the action (Coleman, 1990). In California, the government uses the market to deal, in part, with the externalities of industrial pollution. Rather than establishing the degree to which individual firms can pollute, the state issues certificates for the right to pollute at given levels. These rights are then bought and sold by firms that produce the pollution; firms that value more highly the right to pollute are willing to pay

more for the certificates. However, in the case of most externalities, such markets are not feasible. Every smoker in the workplace cannot strike a deal with every non-smoker.

The final condition is that no single actor can profitably purchase the right to control the action (Coleman, 1990). The benefit to any single person of avoiding second-hand smoke is unlikely to be worth as much to them as the benefit of smoking is to the smoker. In other words, no individual non-smoker is going to be willing to pay enough to get a smoker to stop smoking. These three conditions do not constitute a norm, nor do they ensure that a norm will develop, but in Coleman's theory, they do provide the basis for the demand for a norm.

#### Network Closure and the Creation of Norms

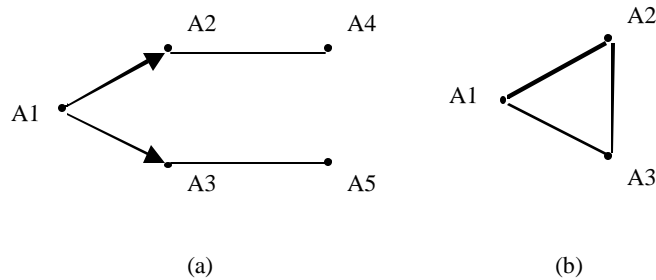
Figure 11 is taken directly from Coleman (1990); note the similarity to Figure 1<sup>1</sup>. Coleman uses the figure to illustrate the difference between an open network and a closed network. In 11(a), there is a deep structural hole between A2 and A3, and also between A4 and A5, while in 11(b) there is no structural hole between A2 and A3; the network is closed. Coleman uses the figure to illustrate that the structures in 11(a) and 11(b) have differing potential for the emergence of norms.

Once the demand for a norm has been established, there must be some mutual transfer of rights, which constitutes the norm, and effective sanctions to enforce the norm.

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<sup>1</sup> Because Figure 11 is taken directly from Coleman (1990), it is important to note that his use of arrows does not carry the same connotation as in typical network diagrams. Coleman uses the arrows to emphasize the separateness of the relations between A1 and A2, and A1 and A3. In typical network diagrams, such one-way arrows would be used to mark the relation as non-reciprocal or asymmetric; e.g., A1 trusts A2 but A2 does not trust A1.

Figure 11  
Network Closure  
Coleman (1990), p. 269



As Coleman notes, this “in turn depends on the existence of a social relationship between two actors affected by the actions of a third” (Coleman, 1990, p. 269). In the absence of a relation between themselves, A2 and A3 have no means of combined action with respect to A1, their only relations are with A4 and A5. However, when they do have a social relationship, A2 and A3 can communicate about their mutual interest in A1’s action. They may simply share information needed to enforce a sanction or they may actively work together to sanction A1, using whatever leverage they have available. For the purposes of this study, the means or functioning of these sanctions and norms is less important than the straightforward observation that in the absence of a relation between A2 and A3, norms cannot emerge. Further, as Coleman is careful to note, though we use a simple triad to illustrate the structural effects, network closure is just as important to the development of norms in larger social structures. Thus, though not within the scope of this study, one might speculate that networks characterized by large numbers of deep structural holes would also be characterized by fewer and less effective norms.

Conversely, a network characterized by a few shallow structural holes also might have many well-established and highly effective norms of behavior.

### Maximizing Group Trust

Network closure is also important to the development of trust in any social structure (Coleman, 1990). Actors are not always trusted to the extent warranted by their trustworthiness. For example, a new employee is unlikely to be highly trusted regardless of how trustworthy the person actually is. The other employees will grow to trust the new employee only by observing the actions of the new employee. Coleman proposes that some degree of network closure is necessary if the actor is to be trusted at levels warranted by the actor's trustworthiness, as illustrated by Figure 12.

Figure 12 illustrates how a small group composed of actors A, B, and C grow to trust T's performance capability when only B has actually observed T's performance.<sup>2</sup> In 12(a), A trusts B's judgment about the performance of other employees, C trusts A's judgment, and B trusts T's performance capability. Thus, in 12(b), relying on B's judgment, A trusts T's performance. Because C observes A's trust in T's performance and trusts A's judgment, C also trusts T's performance, as shown in 12(c). Finally, in 12(d), B, who trusts C's judgment, observes C's trust in T and increases his own trust in T's performance. Indeed the end result of these processes can be system-wide trust in T's performance. Though processes such as these can lead to inflationary and deflationary spirals (Burt & Knez, 1996), increasing levels of network closure enable higher levels of

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<sup>2</sup> The small "j" in the diagrams denote that one actor trusts the judgment of another, while the small "p" denotes that one actor trusts the performance capability of another.

trust in the community and help individuals in the system decide whether or not to trust (Coleman, 1990).

Figure 12  
Creating Trust in a Network  
Coleman (1990), p. 190

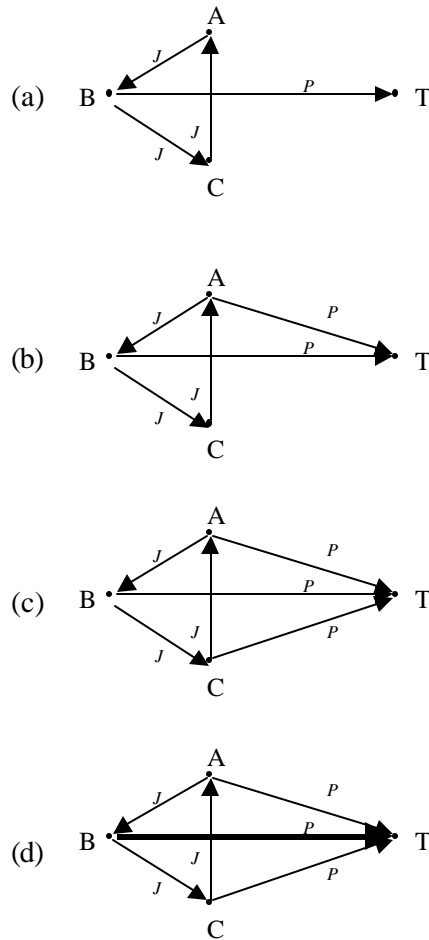


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<sup>3</sup> The small "j" in the diagrams denote that one actor trusts the judgment of another, while the small "p" denotes that one actor trusts the performance capability of another.

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#### Simmel's Triad and Simmelian Ties

As noted previously, the fundamental structural unit of Burt's (1992) structural hole theory is the pair of dyads illustrated in the open triad of Figure 1. Simmel (1950, originally published in 1908), a German sociologist, examined at length dyads and triads, providing a substantial theoretical basis for the position that closing the triad creates a structural unit that is fundamentally different from a dyad. In Simmel's (1950) theory, dyads have distinct characteristics, intimacy being one example, which are fundamentally changed by the addition of a closely tied third member, in which each actor acts as an intermediary between the other two. Simmel uses the example of the addition of a child to a marriage to illustrate the degree to which a closely tied third changes the nature of the relations. Interestingly, Simmel also suggests that the expansion of the closed triad to include other members does not correspondingly modify the nature of the group. A second or third child does not have the same impact on the household as does the addition

of the first child. Thus, Simmel concentrates on the implications of closing the triad and the ways in which the closed triad influences both individual and group behavior.

As presented by Krackhardt (1996), Simmel (1950) distinguishes triads from dyads on several grounds. First, Simmel holds that closing the triad such that all three members share a strong tie reduces each member's capacity for individual action because in a triad a majority can out vote any individual. This is consistent with Coleman's (1990) theoretical formulation regarding network closure and the emergence of norms. By definition, norms reduce individuality in that they constrain individual behavior and, at a minimum, a closed triad is a necessary condition to the emergence of a norm.

Second, Simmel (1950) notes that triads reduce the bargaining power of the individuals. Recall that Burt (1992) uses Simmel's *tertius gaudens* strategies as the theoretical basis for his idea that structural holes (i.e., open triads), generate significant control benefits for the actor who has strong ties to two others who do not share a strong tie between themselves. The lack of a strong tie between the others significantly increases the bargaining power of the *tertius*.

Third, the closed triad holds the potential to reduce conflict in the relationships. When inevitable conflicts arise in any of the three dyads that make up the closed triad, the third member is available to mediate the conflict, to suggest solutions, to use the strong tie with each to moderate the conflict. As Simmel (1950:145) put it, "The appearance of the third party indicates transition, conciliation, and abandonment of absolute contrast (although, on occasion, it introduces contrast)." Simmel's theory is consistent with research showing that in comparison to high-conflict organizations, the

network structures of low-conflict organizations are characterized by clearly identifiable sub-groups sharing large numbers of both internal and external strong and reciprocated ties (Nelson, 1989).

Krackhardt (1996: 8) has coined the term “Simmelian ties” to describe the closed triad; “Two people are ‘Simmelian tied’ to one another if they are reciprocally and strongly tied to each other and if they are each reciprocally and strongly tied to at least one third party in common.” Krackhardt argues that Simmelian ties, a strong tie to one another reinforced by strong ties to a common third, is a qualitatively different tie from a strong reciprocal tie not supported by strong ties to a common third, just as a triad is qualitatively different from a dyad.

#### Simmelian Ties and Individual Effectiveness

Given the recent introduction of Simmelian ties as a specific network construct (Krackhardt, 1996), there are no published studies that utilize Krackhardt’s construct. Nonetheless, the following sections will review evidence for the proposition that individual outcomes are benefited by strong ties and closed triads. Granovetter’s theory of structural embeddedness and empirical evidence supporting it will first be reviewed, as it is a theory positing the value of strong (i.e., embedded) ties. Next, the value of trust and norms of cooperation to the achievement of important individual outcomes will be examined.

#### Structural Embeddedness

In 1985, Granovetter wrote a second landmark piece, *Economic Action and Social Structure: The Problem of Embeddedness*. In this article and a subsequent essay (1992),



Granovetter attempted to draw a middle-ground between the under-socialized view of action embraced by neo-classical economics and the over-socialized view of action that characterizes much of modern sociology. As Granovetter notes, the main-line tradition of neo-classical economics is to explain human behavior on the basis of rational actors purposefully making decisions and taking action that maximizes utility, divorced from any consideration of social effects. Economists themselves have separated economics from sociology on the basis of rational v. irrational behavior (Samuelson, 1947). Conversely, Wrong (1961) criticized sociology as working from a view of people as being overwhelmingly sensitive to norms and the opinions of others, to the point of being stripped of any notion of individual preferences or decision-making. Similarly to Coleman (1990) and Marsden (1981, 1983), Granovetter (1992) observed that both conceptions of action are inadequate to describe economic activity: “Actors do not behave or decide as atoms outside a social context, nor do they adhere slavishly to a script written for them . . . Their attempts at purposive action are instead embedded in concrete, on-going systems of social relations” (p. 32).

For Granovetter (1985, 1992), embeddedness represents the idea that all actions and outcomes, social and economic, are affected by actors’ dyadic relations and the larger structure of relations of which they are part. Thus, like Burt (1992), Coleman (1990), and Simmel (1950), Granovetter (1985, 1992) is careful to distinguish between the effect of the dyad on an actor, which he refers to as *relational* embeddedness, and the effect of the larger structure, which he refers to as *structural* embeddedness, emphasizing, in particular, the role that network structures play in the development and maintenance of

trust. For example, Williamson (1975, 1981) holds that organizations are a set of governance and control mechanisms, which are required to combat opportunism; no opportunism, no need for an organization (Ghoshal & Moran, 1996). In this organizational view, the concept of trust becomes virtually meaningless as the various control mechanisms become a substitute for it. In contrast, Granovetter's structural embeddedness argument stresses that networks of social relations do create trust and diminish the need for institutional arrangements that protect against opportunism. As evidence, Granovetter points to the importance of reputation and the widespread preference for dealing with people referred to individuals by someone they know. Indeed, strategy theorists increasingly view reputation as a valuable asset (Hall, 1992) and an important source of economic rents and competitive advantage (Barney, 1991).

Though many aspects of the structural embeddedness argument are similar to those of Coleman (1990) on the benefits of network closure (in creating and using reputation for example), embeddedness as formulated in Granovetter's essays is conceptually vague and not amenable to specific prediction. Thus, one of his graduate students, Uzzi (1996, 1997), undertook to develop a research program to derive and test a set of hypotheses on embeddedness and performance. Uzzi first undertook an ethnographic study of 23 New York based apparel firms, conducting 117 hours of interviews with 43 persons. Since the purpose of the research was to understand the effect of relations on the economic activity of the firms, the fieldwork focused on the functions and features of the inter-firm ties. Uzzi found that firms differentiated between arms-length/market ties and close/special relationships; the former being analogous to

weak ties and the latter to strong ties. Uzzi found that the close and special ties, which he refers to as embedded ties, perform three valuable functions in the relationship between two firms:

- (1) they embody trust, obviating the need for protections against opportunism,
- (2) they enable the transfer of “fine-grained” (1996, p. 677) information, which was often both proprietary and tacit, similar to many intra-organizational information flows, and
- (3) they result in joint-problem solving arrangements that “enable actors to coordinate functions and work out problems ‘on the fly’” (1996, p. 679).

Thus, the features and functions of embedded ties, as found by Uzzi (1996, 1997), are largely consistent with the theory on the effects of network closure. Embedded ties are characterized by the high trust levels theorized to be consistent with high levels of network closure. The creation of trustworthiness and trust is fueled by network closure and Simmelian ties. Further, Uzzi found that embedded ties enable coordination by mutual adjustment and thus, would be expected to be associated with high levels of task interdependence.

Indeed, the dyadic ties making up a Simmelian triad might be considered to be embedded ties, as defined by Uzzi (1997), in that they are supported by and promote high trust levels. Nonetheless, embedded ties and Simmelian ties are not synonymous. Embedded ties are merely close, special, and strong ties between two actors, while Simmelian ties involve a third actor. Simmelian ties are embedded ties in which the actors have embedded ties to a common third actor. Though not synonymous, embedded

ties often result in the creation of Simmelian ties; that is, they do so to the extent that transitivity in the triad holds<sup>4</sup>.

This tendency toward closing of the triad (i.e., toward transitivity) is a key structural property in network analysis (Wasserman & Faust, 1994). In developing his strong ties thesis on the importance of Simmelian ties, Krackhardt (1996) notes that research into these triads has generally found that the probability that the triad is closed is greater than one would expect based on random choice (Davis, 1979). However, Krackhardt also notes that transitivity does not hold for even half of the open triads in Davis' study. If it held 100% of the time, all actors in a network would be locked into tightly bound cliques of strong ties in which no actor would be connected to anyone outside the actor's own clique. Still, the tendency toward the closing of a triad of embedded ties was borne out by Uzzi's (1996) research, wherein it was found that embedded ties often resulted from third-party referrals. For example, one CEO used her ties to two unconnected firms to bring them together by transferring expectations of behavior and reciprocity for past favors, thereby closing the triad. Thus, if the CEO is taken to be the focal actor in the open triad of Figure 1 with embedded ties to both B and C, the CEO brought these two unconnected actors together, enabling the creation of an embedded tie between B and C, thereby closing the triad and creating Simmelian ties among the three actors.

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<sup>4</sup> The reader will recall that in network analysis, a relation is said to be transitive when the relation holds between every pair of successive actors in a sequence and it holds for any two actors. In other words, if A "chooses" B as a friend, B "chooses" C as a friend, and A "chooses" C as a friend, then friendship is a transitive relation.

### Embeddedness and Effectiveness

Consistent with Ring and van de Ven's (1992) theory of the development of cooperative inter-organizational relationships and Coleman's (1990) theory on the importance of network closure, Uzzi (1996) found that embedded ties develop incrementally and usually begin with an initial "stock of trust appropriated from a preexisting social relation" (p. 682). The embedded ties enable firms to reduce monitoring costs, to speed up decision-making, and to improve their organizational learning and adaptation. After completing his ethnographic research, Uzzi (1996) collected data on network ties among all better dress apparel firms in New York. The level of embeddedness for a tie was set as the percentage of a firm's total business flowing across the tie; the larger the percentage, the more embedded the tie. Then, the embeddedness of a firm was set as the ratio of arm's length (low volume) ties to embedded (high volume) ties. The probability of firm failure was set as the dependent variable. Uzzi found that the firms with moderate levels of embeddedness enjoyed the lowest probability of failure; the probability of failure increased as firms became both less embedded and more embedded. This U-shaped function implies that embeddedness yields positive benefits as outlined above, but only to a point. A firm that becomes over-embedded becomes too reliant on a few partners and is unable to gather new, valuable, and non-redundant information. Optimal networks integrate arm's length ties and embedded ties to balance the information and control benefits of non-redundancy with the adaptive, learning, and efficiency benefits of trust relations.

With respect to this study, one must consider whether these firm-level effects are also likely to be found at the level of the individual in a firm. Granovetter's (1985) original embeddedness argument is largely an economic argument, so the question is whether the actions and exchanges that take place among persons in organizations can be considered as economic actions and exchanges for purposes of the argument. It is reasonable to hold that they can. Granovetter (1992) purposefully adopted Weber's broad definition of economic activity; namely, that economic activity is all action in which the actor's satisfaction of a perceived need depends "upon some relatively scarce resources and a limited number of possible actions" (Weber, 1924; from Granovetter, 1992). Certainly, there is little that takes place in an organization that is not encompassed by this definition, and, indeed, there are few subjects left that economists consider outside their sphere of interest. Given the theoretical parallels and linkages between the embeddedness, structural holes, and network closure arguments, there is ample reason to believe that the embeddedness effects found by Uzzi at the level of the firm would also be found at the level of the individual.

### Trust and Effectiveness

As proposed by Coleman (1990), strong ties and network closure are essential to the development of norms and trust through joint action and reputation; network closure enables a person to be trusted to the extent warranted by their trustworthiness. Further, there are numerous ways that trust influences personal effectiveness in an organization. In the following paragraphs, three such means will be reviewed: cooperation, learning,

and efficiency. Each of these delivers tangible benefits to those who are trusted and creates significant advantages for them over others who are not trusted.

As noted earlier, theories and studies of cooperation and cooperative behavior at all levels of analysis have recently become prominent in the organizational literature. For Anderson, Rungtusanatham, and Schroeder (1994), cooperation is “collaboration among different individuals, groups, or organizations, where all entities are engaging in noncompetitive, mutually beneficial, win-win activities” (1994: p. 483). Though not synonymous with trust, cooperation and trust enjoy a symbiotic relationship; cooperation produces trust and trust produces cooperation (Ghoshal & Bartlett, 1994). Trust facilitates the development of cooperation and higher levels of trust will lead to higher levels of cooperation (Krackhardt & Stern, 1988). Being embedded in a valuable network of trust relations enables individuals to promote and benefit from mutual cooperation both externally and internally.

The development of interorganizational relationships (IORs) has received much attention in recent years (Barley, Freeman, & Hybels, 1992; Ring & Van de Ven, 1994; Shan, Walker, & Kogut, 1994). Ring and Van de Ven (1994) in particular have examined the processes by which IORs develop. IORs, and the personal relationships that make them work, emerge incrementally and often begin with small, low-risk transactions that allow trust to develop between the organizations and the individuals. Interestingly, this creates a dilemma for the individuals. Though they may be increasingly willing to rely on trust as the IOR develops, increasing organizational stakes may require greater reliance on formal means of maintaining confidence. In other words,

the development of trust in an IOR does not preclude the development of formal trust-supporting mechanisms.

Though one sometimes thinks of trust existing between firms, such trust is a function of relationships between individuals within an industry or market who function as boundary spanners. Ring and Van de Ven (1994) note that IORs are often bound closely to personal relationships and dissolve when the people change. Kogut, Shan and Walker (1992) have done considerable work in understanding the dynamics of the biotechnology industry and its numerous startup firms. Though preliminary, their work has shown that a firm that is deeply embedded in the interfirm network of technologists and venture capitalists is more likely to develop beneficial cooperative relations. Drawing on Coleman's (1986) concept of social capital and on Granovetter's (1985) concept of embeddedness, Kogut et al. have shown that the number of cooperative relations is primarily attributable to the firm's network position and whether it is publicly funded. Similarly, in a study of investment banking firms, Baker (in Mizruchi & Galaskiewicz, 1994) found that preexisting ties between companies and the interpersonal ties between officers greatly influenced the development of cooperative relations. Such ties work to decrease the distrust inherent in market exchanges between strangers.

The personal relationships underlying cooperative IORs are vulnerable to turnover and interpersonal difficulties. In a study of two technological collaborations, Dodgson (1993) demonstrated that the survival of the relationships requires the establishment of interorganizational trust. As developed by Dodgson, such trust is



characterized by a community of interest, cultures that are open to external inputs, and values that support the sharing and open dissemination of knowledge.

Thus, to summarize by way of example, if the cliques in Figure 7(a) represent two separate organizations and the tie joining E and F is assumed to be a strong, trusting tie, individuals E and F are in a position to promote cooperation between the firms on the basis of the existing trust relation between themselves. The social capital represented by their link make E and F more valuable to, and effective within, their respective organizations.

An actor's internal trust relations are no less a valuable resource than are external trust relations. In an experimental simulation, Krackhardt and Stern (1988) examined the notion that organizations with a particular social network structure are more effective in dealing with crises than are most organizations. The fundamental premises of their work were that organization members cluster into friendship cliques; that crises create inter-unit conflict, which reduces cooperation, but require cooperative adaptation if the crisis is to be surmounted; and that trust, which is implied by friendship, enhances cooperation. Thus, in times of crisis, organizations whose units have stronger friendship links, and by extension trust links, will be more effective. Six trials of the experiment supported the proposition. By reducing uncertainty, trust enables individuals to rely on undistorted communications and collaborative efforts in times of crisis (Mishra, 1996; Webb, 1996). All else equal, a person embedded in a network of trust relations is more likely to weather an organizational crisis than is an isolated person.

In a more recent study, McAllister (1995) examined the affective and cognitive dimensions of trust and their relationship to the behavior and performance of managers and professionals in organizations. McAllister found a positive relationship between focal manager affiliative citizenship behavior and supervisory assessment of performance, but found that the relationship did not hold for assistance-oriented citizenship behavior. Affiliative behavior is affect-laden, centered on care and concern, in contrast to the task-oriented, more practical assistance behavior. Thus, though not part of McAllister's study, it may be that managers value highly the cultivation of resilient, affective relationships, namely trust, recognizing that such relations are often necessary as the basis for coordinated action. Indeed, at one extreme, Ouchi's (1981) theory of clans as an efficient organization form in some situations is predicated on high levels of shared norms, values, and trust, enabling more effective cooperation and a lesser need for formal governance.

Trust also promotes individual and organizational learning. Nearly all models of individual and organizational learning are based on two levels of learning. The first level is characterized by the acquisition and development of routines and skills, which Kim (1993) refers to as "know-how." The second level is characterized by the ability to conceptualize and generalize experience, which Kim refers to as "know-why." In the first level, what Argyris and Schon (1978) refer to as single-loop learning, we develop routines and skills based on whether appropriate consequences result from our actions. If they do not, we modify the actions and try again. In the second level, Argyris and Schon's double loop learning, the individual modifies the variables which govern the

relationship between actions and consequences. Most learning is first-order learning, but what is usually referred to as organizational learning implies second-order learning, which creates the ability to adapt to uncertain conditions by changing the governing variables (Sitkin, Sutcliffe, & Schroeder, 1994).

An essential element of second-order learning is experimentation with new approaches (Kim, 1993). Experimentation involves the systematic searching for and testing of new knowledge. Encompassing both on-going programs and one-of-a-kind demonstration projects, learning organizations invest in the capability to take risks, to make mistakes, and to innovate (Garvin, 1993). Argyris (1992) recognized that under conditions of mistrust, experimenting with double-loop corrections requires that trust displace mistrust, enabling individuals to make themselves vulnerable. Innovation emerges from uncertainty. If individuals fear that others will take undue advantage of them in times of uncertainty, change and innovation will be much more difficult (Bromiley & Cummings, 1995). Thus, highly trusted persons (i.e., those embedded in a network of trust relations) will take greater risks and innovate more aggressively in the workplace, giving them a competitive advantage over their peers. Consequently, it is not surprising that some theorists hold trust to be an essential characteristic of a learning environment (Hanssen-Bauer & Snow, 1996).

In addition to promoting the development of cooperation and effective learning, Bromiley and Cummings (1995) have proposed that trust enhances organizational effectiveness by lowering transaction costs in the firm and creating numerous economies and benefits. Simply put, they propose that low trust levels require the imposition of

significant and costly controls, whereas high trust levels reduce the need for, and cost of, making, monitoring, and enforcing agreements. Transaction cost economics (TCE) has been revitalized by the work of Williamson (1975, 1981, 1996). TCE proposes that the governance structure for any transaction can be predicted based on the level of asset specificity in the transaction, the uncertainty surrounding the transaction, and the frequency of interaction of the parties to the transaction (Chiles & McMackin, 1996). Bromiley and Cummings (1995) note that because transaction costs are partly a function of the risk of opportunistic behavior, such costs are in part a function of the strength of the trust relations. For example, the costs of writing contracts to govern transactions are transaction costs. Two business people who share a strong trust relation may feel no need to employ lawyers to protect each other from opportunistic behavior, whereas two business people with no such relation will attempt to protect themselves by hiring attorneys to write carefully constructed contracts, thereby increasing the cost of the transaction. From this rather intuitive notion, Bromiley and Cummings (1995) derive a number of hypotheses. They propose that by reducing internal and external transactions costs, firms that develop a network of trust relations will:

1. more effectively contract in the marketplace for services and reduce the need for internalization,
2. reduce expenditures on control systems,
3. rely more on non-financial reporting criteria and collect less detail about processes,

4. reduce the amount of bias in forecasting and “sandbagging” in budgets as a result of greater risk-taking,
5. develop more interdivisional projects as a result of more effective boundary spanning and cooperation, and
6. enjoy more innovation and faster learning.

Though Bromiley and Cummings (1995) focus on a firm-level analysis of trust and efficiency, these macro-level benefits are derived from a network of trust relations within the firm and the relations built by its members with people in other organizations. To the extent these networks are more extensive and include stronger relations, the greater the possible efficiency benefits. In other words, it is the micro-level building of one-on-one trust relations, facilitated by the firm’s actions, which leads to the macro-level benefits for the firm. It follows that many of the efficiency benefits at the firm-level will flow disproportionately to those employees with the larger, stronger, more effective personal trust networks. For example, an employee with an effective network of trust relations is more likely to assemble an efficient project team than is the employee who is less trusted. The more trusted employee is likely to enjoy greater freedoms and be able to innovate more aggressively, which should result in greater personal effectiveness. Though some of the benefits hypothesized by Bromiley and Cummings are limited to the level of the firm, such as the investment in control systems, many of the efficiency benefits will accrue disproportionately to employees who enjoy a larger and stronger network of trust relations.

Table 4 summarizes the empirical research reviewed above, which supports the notion that trust and strong relationships often play an important role in improving individual and organizational performance. Given the value of being trusted and the importance of network closure to building trust and being perceived as trustworthy, it is hypothesized that:

H2: There is a positive relationship between Simmelian ties and individual effectiveness.

#### The Moderator Hypothesis: The Role of Task Interdependence

Though there is theoretical and empirical support for the value of an open network populated by large numbers of structural holes and for the value of a closed network characterized by large numbers of Simmelian ties, any single actor's network cannot be both open and closed. An actor's network can only be more closed or less closed, more open or less open. In the end, the degree to which structural holes and Simmelian ties are opposite sides of the same coin, i.e., perfectly negatively correlated, is an empirical question. Still, there is a theoretical basis for believing that while they may be negatively related, they are not perfectly correlated. Recall that non-redundancy is the essence of structural holes and that contacts can be redundant by structural equivalence, in that they share no direct tie but know the same people, or they can be redundant by cohesion, in that they do share a direct tie. In network A/1 of Figure 9, the focal actor's contacts 1 and 2 are redundant due to cohesion and there is no structural hole between them for the focal actor to exploit; moreover, the three actors also may be referred to as being Simmelian-tied. The direct tie between contacts 1 and 2 can be subtracted,

Table 4  
Summary of Studies Supporting Simmelian Ties Hypothesis

Source	Findings
Baker (in Mizruchi & Galaskiewicz, 1994)	Pre-existing ties between companies and the interpersonal ties between officers influence the development of cooperative relations.
Dodgson (1993)	Interpersonal trust facilitates cooperation and learning between independent research organizations.
Kogut, Shan, & Walker (1992)	Evidence of a U-shaped relationship between network embeddedness and rate of alliance formation.
Krackhardt & Stern (1988)	Trust and friendships in the workplace enable organizations to improve crisis response.
McAllister (1995)	Affiliative behavior in the workplace is affect-laden, not task-oriented.
Uzzi (1996, 1997)	There is a U-shaped relationship between embedded ties and performance.

as in network A/2 of Figure 9, thus eliminating the Simmelian ties, but this still does not create a deep structural hole because contacts 1 and 2 are somewhat redundant due to structural equivalence, in that contacts 1 and 2 share two common ties. In practice, contacts are more or less redundant; structural holes are more or less deep. Further, Burt (1992) notes that cohesion, and the presence of a Simmelian tie, is the surer indicator of redundancy. It seems highly unlikely that an actor with a large number of structural holes would also have a large number of Simmelian ties. Thus, it is hypothesized that:

H3: The extent to which a network is characterized by structural holes is negatively related to the extent to which a network is characterized by Simmelian ties.

If structural holes and Simmelian ties are, at least partly, mutually exclusive, there is an obvious question as to why we find empirical data and theory suggesting that both open and closed networks can result in favorable outcomes for the focal actor. One explanation is that there is a third variable that moderates the strength or form of the relationship between structural holes and effectiveness and the relationship between Simmelian ties and effectiveness. It is suggested here that such a moderating variable is at work, namely, the focal actor's task interdependence in the work environment.

#### Task Interdependence

According to Scott (1992, p. 230), task interdependence “refers to the extent to which the items or elements upon which work is performed or the work processes themselves are interrelated so that changes in the state of one element affect the state of the other.” In 1967, Thompson introduced a conceptual framework to explain the task interdependencies among organizational actors. Thompson's scheme distinguishes among three broad types of interdependencies. In pooled coupling, the actors share resources, but otherwise work independently. For example, in a university setting the faculty share resources such as classrooms and administrative support, but each operates very independently, at least historically. In sequential coupling, the actors pass work off one to another, similar to a linear assembly line. In reciprocal coupling, the elements of work relate to each other as both inputs and outputs (i.e., the actors feed work back and forth among themselves) (Scott, 1992). Reciprocal coupling represents the highest degree of task interdependence (Mintzberg, 1979). The greater the degree of task interdependence, the more resources that must be devoted to coordination (Scott, 1992).



Thus, work based on significant reciprocal coupling, where inputs and outputs move among the actors variously and continuously requiring ongoing reciprocal feedback, often requires the use of mutual adjustment as the coordinating mechanism. In such cases, standardization of work, outputs, and skills are often simply insufficient to meet the demand for information exchange and joint action by the actors (Galbraith, 1977; Scott, 1992).

As noted by Wageman (1995), tasks often can be structured to be more or less interdependent. In her field experiment involving 400 copy machine repair technicians, Wageman found that in some areas the technicians worked very independently, in others they worked collectively with high interdependence, while in others the work environment could be characterized as a hybrid, combining aspects of both independent and interdependent work environments. Wageman's study is an excellent example of the interplay of group processes and interdependence.

Among other research questions, Wageman (1995) explored the differential effects of task interdependence and outcomes interdependence, defined as the degree to which significant rewards depend on the performance of others, on group functioning. Consistent with earlier research (Crawford & Haaland, 1972; Rosenbaum et al., 1980; Thomas, 1981), Wageman found that the highly interdependent groups "exhibit high-quality social processes, extensive mutual learning, and a sense of collective responsibility for performance . . . [and] encourage strong norms supporting high levels of cooperation and effort" (1995: 174). Additionally, it is important to note that her significant effects were present despite the fact that the task interdependence of her

highly interdependent groups did not represent a high degree of reciprocal coupling. Instead, even in the groups categorized as highly interdependent due to shared responsibility and assignments, the actual repair of copy machines was still accomplished by individual technicians. Wageman found that the degree of task interdependence had strong and independent effects on the group processes, while outcome interdependence had no independent effect, but only supported the effects of the task interdependence.

Wageman's (1995) findings are consistent with the observation made earlier that high task interdependence is likely to require mutual adjustment as a key means of organizing the work. Further, effective mutual adjustment as a coordination mechanism relies on the development of resilient and cohesive effective group processes, such as the development of a group identity, enforcement of norms of cooperation and reciprocity, and the creation of trust (Cheng, 1983; Saavedra, Earley, & Van Dyne, 1993; Shea & Guzzo, 1987). As suggested by Coleman (1990) and Simmel (1950), such group processes are all enhanced by, or in many cases require, a significant level of network closure via large numbers of Simmelian ties. Conversely, a network characterized by large numbers of structural holes is going to promote independent action based on information and control benefits for the focal actor. Thus, it is hypothesized that:

H4a: Networks characterized by structural holes are negatively related to task interdependence among network actors.

H4b: Networks characterized by Simmelian ties are positively related to task interdependence among network actors.

There are no published empirical studies that examine the relationships among task interdependence, social structure, and effectiveness at the level of the individual. However, Gulati (1995) undertook a comprehensive longitudinal multi-industry study of alliance formation between 1970 and 1989 among strategically interdependent firms. Not surprisingly, he found that two highly interdependent firms are more likely to undertake an alliance than two which are not interdependent. Further, given the incremental development of cooperative inter-organizational relationships (Ring & Van de Ven, 1994), he found that firms with past alliances are more likely to form new alliances. However, most importantly, at least in the context of this study, all firms, interdependent or not, were more likely to form an alliance when they shared a common third party than when they did not; and if the firms also were strategically interdependent, the likelihood of an alliance was significantly greater still. In network terms, an alliance between firms was most likely when it represented the creation of a Simmelian tie between two strategically interdependent firms and was least likely when it represented a tie between two firms lacking strategic interdependence and not tied to a common third party. This seems reasonable when one considers the importance of reputation in alliance formation and the value of a referral from a common, and trusted, third party (Barney & Hansen, 1994; Dollinger, Golden, & Saxton, 1997), and the use of trust as a governance mechanism which lowers transaction costs (Dyer, 1997; Nooteboom, Berger, & Noorderhaven, 1997; Walker, Kogut, & Shan, 1997).

Network closure, represented by the Simmelian ties, is bound closely to the creation and maintenance of trust and cooperation among firms, groups, and individuals.

As trust and cooperation become more important, as in the case of increasing task interdependence, so do Simmelian ties. Those who are successful in such environments will be those actors who are able to build and maintain a network of trust-enhancing Simmelian ties. Thus, it is hypothesized that:

H5a: The level of task interdependence will moderate the relationship between structural holes and individual effectiveness; the rate of increase in individual effectiveness with respect to structural holes is greater for low levels than for high levels of task interdependence.

H5b: The level of task interdependence will moderate the relationship between Simmelian ties and individual effectiveness; the rate of increase in individual effectiveness with respect to Simmelian ties is greater for high levels than for low levels of task interdependence.

#### Summary

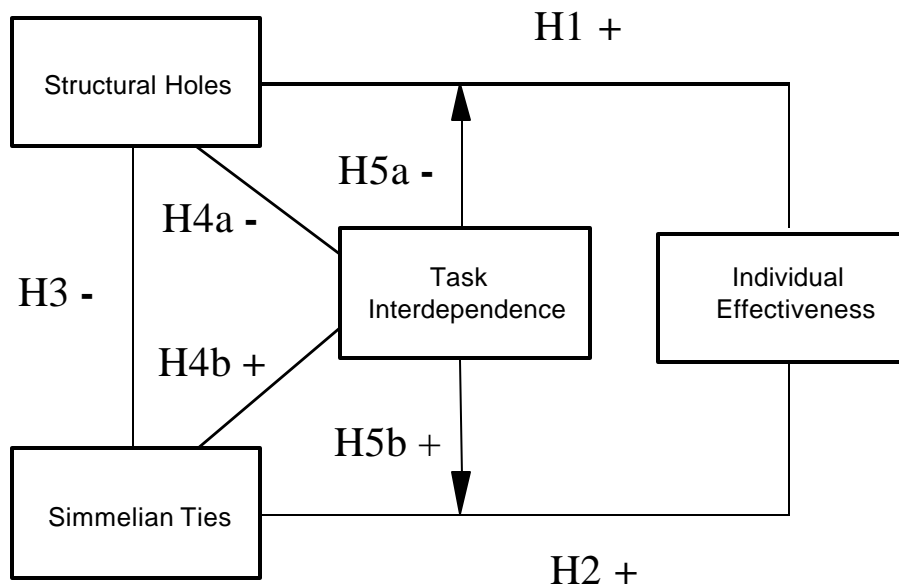
This chapter has presented the development of structural hole theory and Simmelian tie theory. Further, both structural holes and Simmelian ties have been shown to influence individual effectiveness in the workplace. Structural holes provide actors with important information and control benefits. Simmelian ties provide actors with important relational benefits which promote the development of cooperation, trust, and learning. Because, to some extent, structural holes and Simmelian ties are mutually exclusive, it has been suggested that task interdependence moderates the relationship of structural holes and performance and the relationship of Simmelian ties and performance.

The hypotheses are consolidated in Table 5. Additionally, the research model, based on the theoretical model introduced earlier in this chapter, is illustrated in Figure 13, wherein the hypothesized relationships are labeled with the appropriate hypothesis.

Table 5  
Summary of Hypotheses

H1: There is a positive relationship between structural holes and individual effectiveness.
H2: There is a positive relationship between Simmelian ties and individual effectiveness.
H3: The extent to which a network is characterized by structural holes is negatively related to the extent to which a network is characterized by Simmelian ties.
H4a: Networks characterized by structural holes are negatively related to task interdependence among network actors.
H4b: Networks characterized by Simmelian ties are positively related to task interdependence among network actors.
H5a: The level of task interdependence will moderate the relationship between structural holes and individual effectiveness; the rate of increase in individual effectiveness with respect to structural holes is greater for low levels than for high levels of task interdependence.
H5b: The level of task interdependence will moderate the relationship between Simmelian ties and individual effectiveness; the rate of increase in individual effectiveness with respect to Simmelian ties is greater for high levels than for low levels of task interdependence.

Figure 13  
Research Model



## CHAPTER 3

### METHODS

This chapter outlines the research methods used to test the hypotheses presented in Chapter 2. The type and number of subjects used in the study will first be reviewed, outlining some methodological issues that are specific to network studies. Next, the measures and the data collection procedures will be outlined.

#### Subjects

The unit of analysis in this study is the individual. In a non-network organizational field study, the researcher would typically select a sample of respondents from one or more organizations. In a network study, however, sampling, establishing network boundaries, and data collection are interrelated issues that must be considered when selecting the subjects to be included in the study. The following sections will discuss each of these issues in turn.

#### Sampling Networks

One procedure for selecting subjects for the study would be to take a random sample of the appropriate population and ask them to describe their personal networks. The respondents could describe the strength of their relationships with their primary contacts and might be able to provide data about their secondary contacts; that is, the contacts of their contacts. Sometimes referred to as “quasi-sociometry,” this method has been found to be modestly accurate in assessing the structure of strong ties (Bernard &

Killworth, 1977; Bernard et al., 1985; Rogers & Agarwala-Rogers, 1976; Rogers & Kincaid, 1981) and was used by Burt (1992) in his structural holes studies. However, in this study, the structure of all ties is of interest, and, as one would expect, there is no evidence that actors can accurately assess the networks of those to whom they are weakly tied. Thus, to assess the effects of primary, secondary, and tertiary contacts of varying strength, one must assess the entire network in which the subject is a single actor (i.e., the whole network). Hence, this study assessed the whole networks of subjects in the organizations included in the study.

Having established that one needs to assess the whole network, the researcher must confront the fact that there are no widely accepted means of sampling a whole network (Ibarra & Andrews, 1993). Burt (1983) has estimated that the amount of relational data lost through sampling is roughly equal to  $k$  per cent, where  $k$  is the sample size as a percentage of the whole network; thus, sampling only 10% of the actors in the network results in a loss of 90% of information about the structure of relations. Even a 50% sample of the actors would involve the loss of half the data (Scott, 1991). Despite recent efforts to more carefully examine the loss of information when inferring from a sample of relationships to the whole network (Burt & Ronchi, 1994), network researchers do not typically sample respondents when studying whole networks, they collect data from all members of the network (Krackhardt, 1990; Hartman & Johnson, 1989; Ibarra, 1993).

### Network Boundaries

Having established that data must be collected from all members of the whole network, the boundaries of the network must be determined, as errors can distort the overall configuration of actors in a system (Laumann, Marsden, & Prensky, 1989). When the network has no natural borders, determining appropriate boundaries -- who is in the network and who is not -- can be very problematic. However, in this study, the respondents are individuals in the workplace, providing natural boundaries for an intact network (Rogers & Kincaid, 1981), in that the network boundaries can be drawn at the workplace borders. Because workplace relationships might span several locations in multi-location organizations, the network boundaries can be further delineated by including only organizations that are in a single location, or at least have little interaction with other locations in the organization. Though there are still risks that the network structures in the study will be influenced by actors outside the organizations, the procedures outlined here substantially reduced such risks.

### Data Collection

Sociometric data can be collected by several means. In some network studies, the researcher uses archival data to construct relationship patterns, the study of interlocking directorates being a common example. In a field study, the researcher could attempt to actually observe interactions in the workplace and, based on those observations, infer the nature and strength of relationships. Like other qualitative research, direct observation can provide powerful and direct understandings to the researcher. However, such studies



are limited to small systems and do not usually create data which is amenable to formal data analysis of the network structures.

The most common field method of collecting sociometric data is to collect information on relationships by having the network members complete a survey questionnaire about the respondent's ties to other actors (Wasserman & Faust, 1994). Such instruments fall into two broad categories. The researcher can provide each respondent with a name-generating survey, in which the respondents are asked to provide the names of all those with whom they have a relationship. For example, the researcher might ask the respondents to name all those they go to for work-related advice. Alternatively, the researcher can provide the respondents with a list of all possible network members and ask them to indicate those with whom they have a relationship. The advantage of a name-generating survey is that it can be used in a network of any size; however, it increases concerns about informant accuracy (which will be discussed later) and, as noted above, is unlikely to elicit data about weaker ties.

In order to build a full understanding of all ties, weak and strong, in the networks, valued, directed data was collected from all respondents in this study. All respondents were provided with a list of all organization members and were asked to rate the strength of their relationship with every other person in the organization. The definition of relationship strength used was based on the work of Granovetter (1973) in his original work on weak ties and on the work of Burt (1997). Both Granovetter and Burt emphasize that strong ties are typically characterized by frequency of contact, emotional closeness, and duration. Though each of these is somewhat independent of the others, the "set is

obviously highly intracorrelated” (Granovetter, 1973, p. 1361). Thus, the following instructions were provided to respondents:

The purpose of this section of the survey is to assess the “strength” of your relationship with others in *[XXX organization]*. Most people maintain a wide variety of relationships in the workplace; some are “stronger” and some are “weaker.” “Strong” relationships are typically characterized by frequent contact, emotional closeness, and long duration. We trust and confide in those to whom we are strongly tied. “Weak” relationships are typically characterized by infrequent contact and emotional distance.

Those to whom we are weakly tied might be acquaintances of ours, or those for whom we can only associate a name with a face. Below you will find a roster of everyone in *[XXX organization]*. On a scale of 1 to 7, with “1” being a very weak relationship and “7” being a very strong relationship, please circle the rating that best describes the strength of your relationship with each person. If you do not know the person, please put a check mark in the box, “Do not know.”

When constructing the network matrix, the value entered into each cell was the rating provided by the sender of the relation<sup>5</sup>. When the respondent checked the box, “Do not know,” a value of 0 was entered in the appropriate cell, indicating the absence of a tie. In addition, the direction of the tie was assessed by whether the tie is reciprocal.

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<sup>5</sup> The reader will recall that the network was analyzed using a square matrix of all relations. The sender of the relation is carried in the row and the receiver is carried in the column. Since a person cannot send a relation to herself, the diagonal is not meaningful.

For example, if actor A names actor B and actor B names actor A, then the tie is reciprocal. But if A names B and B does not name A, then there is only a tie pointing from A to B. Obviously, in a reciprocal tie, actors A and B might have differing assessments of the strength of their tie. Reciprocity of the tie is important in Krackhardt's (1996:8) formulation of Simmelian ties, in that "two people are 'Simmelian tied' to one another if they are reciprocally and strongly tied to each other and if they are each reciprocally and strongly tied to at least one third party in common."

The most significant implication of this data collection method is that it requires the construction of a roster that includes all employees of the organization. Therefore, practical considerations require that the size of the network, and hence the organization, be limited in order to keep the survey questionnaire to a reasonable size. Therefore, data was collected in three organizations of 30 – 50 members each, creating a total of 113 cases. The following section will present a power analysis showing that 110-120 subjects is a sufficiently large population to ensure an acceptable probability that the statistical tests to be used will yield statistically significant results, thereby strengthening the statistical conclusion validity of the study.

#### Power Analysis

Power analysis is used during and after the design stage of a research study to determine appropriate sample size. A power analysis was conducted using SPSS SamplePower 1.0 (Borenstein, Rothstein, Cohen, & SPSS, Inc., 1997) using a standard alpha level of .05. Cohen's (1988) effect sizes of small (.02) and medium (.15) were used, and power was set to .80. Large effect sizes (.35) were not analyzed as there is no

basis in the social network literature for expecting that the variables in this study will create large effects on the dependent variable. Power analysis techniques vary based on the type of data analysis to be used. As will be elaborated upon in Chapter 4, the primary analytical technique to be used in this study is hierarchical set regression. Because the purpose of the power analysis is to determine the minimum sample size to identify the expected effects, the regression equation that is most restrictive, that is needing the largest sample size to achieve the desired power for a given effect size, was used as the basis for the power analysis.

There are three power analyses in Appendix A, each based upon a regression equation consisting of a four-variable demographic set, a one independent variable set, a one independent variable set, and a one interaction variable set. Each analysis contains two pages: the first includes a main assumption table and the second includes a table relating sample sizes and power. The first analysis (pages 135 & 136) illustrates the sample sizes needed to identify a small effect ( $f^2 = .02^6$ ,  $R^2 = .02$ ; based on Cohen, 1988). As can be seen on page 136, approximately 170 cases would be needed to achieve power of .80, while approximately 120 cases would be needed to achieve power of .60. The second analysis (pages 137 & 138) illustrates the sample sizes needed to identify a medium effect ( $f^2 = .15$ ,  $R^2 = .13$ ; based on Cohen, 1988). As can be seen on page 138,

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<sup>6</sup> Cohen (1988) notes that since the F sampling distribution used in the multiple regression/correlation (MRC) system is the same as that used in the analysis of variance, the same effect size index,  $f$ , is used in the power analysis. However, since the MRC system proceeds using squared correlation values, Cohen uses  $f^2$ , rather than  $f$ , as the effect size index for multiple regression analysis. Nonetheless, he notes that the  $f^2$  index has the same properties and relationships as  $f$ , (e.g., it is the standard deviation of standardized means).

approximately 22 cases would be needed to achieve power of .80. Finally, the third analysis (pages 139 & 140) illustrates the sample sizes needed to identify an effect size midway between small and medium ( $R^2 = .08$ ). As can be seen on page 140, approximately 38 cases would be needed to achieve power of .80.

The final question to be considered is the effect size that can be expected based on the extant research. As noted earlier, there are no published studies utilizing the construct “Simmelian ties” as an independent variable. However, when studying the effect of structural holes on promotion rates of managers in a large organization, Burt found that the correlations of structural holes with promotion rates ranged from .149 to .235 (Burt, 1992). Cohen (1988) recommends that small correlation effects be set at  $r = .10$  and that medium effects be set at  $r = .30$ . Thus, Burt’s findings represent an effect size roughly midway between small and medium. If similar effect sizes for structural holes were found in this study, then 50 cases would be sufficient. However, the dependent variable in this study is a broad and generalized indicator of performance on the job, the variance of which will be influenced by many factors. Thus, it is possible that the effect sizes in this study would be smaller than found by Burt (1992). Thus, a target sample size of 100 – 125 was advisable, even though it is well in excess of the 40 cases required to achieve power of .80 for an effect size comparable to that found by Burt (1992).

#### Description of Sample

113 sociometric surveys were collected. This represents a 100% response rate in Fort Worth (“FW”) (33 of 33), a 100% response rate at GTM Plastics (“GTM”) (45 of 45), and an 88% response rate in Needham (“NEE”) (35 of 40), for an overall response

rate of 96%. FW and NEE are separate offices of a software development firm headquartered in Seattle; their work and organization is very similar. GTM is a plastics manufacturing firm that specializes in high-value complex injection molding for its customers, including parts design. Table 6 compares these organizations with respect to the demographic variables in the study. As can be seen, NEE tends to be younger and less experienced, while GTM is dominated by employees without any college education.

Because there are no theoretical reasons to utilize non-linear transformations of the data, analysis of the potential threats to the correlation and regression analysis, such as outliers, curvilinearity, and heteroscedasticity, will be presented when discussing the results of each hypothesis test and the analysis of residuals.

Table 6  
Organization Demographics

	All cases n = 113	FW n = 33	GTM n = 45	NEE n = 35
Org tenure ( <i>Tenure</i> )				
Mean	4.3	4.3	5.9	2.2
s.d.	4.3	4.2	5.2	1.5
Education ( <i>Educ</i> )				
Mean	15.2	16.3	12.8	17.3
s.d.	2.4	1.6	1.3	1.5
Age ( <i>Age</i> )				
Mean	35.5	35.3	39.6	30.5
s.d.	9.6	9.7	10.3	5.2
Work experience ( <i>Exper</i> )				
Mean	12.9	12.5	17.1	7.9
s.d.	10.0	9.2	11.3	5.8

## Measures

There are four variables of interest in this study, each focused on the level of the individual actor: the actor's structural holes, the actor's Simmelian ties, the actor's task interdependence in the work environment, and the actor's individual effectiveness in the workplace. The following sections will examine the operationalization of each variable.

### Independent Variables

#### Structural Holes

Burt (1997) proposes using two principal indicators of structural holes: constraint and hierarchy. For Burt, the network around each actor constrains the actor's ability to reap the information and control benefits of structural holes to the extent that the network is directly or indirectly concentrated in a single contact. More constraint means fewer structural holes and less social capital; less constraint means more structural holes and more social capital. In addition, Burt introduces a hierarchy index which measures the extent to which the constraint on the focal actor is tied to a single other actor. Ego networks in which all the focal actor's contacts are exclusively tied to a single dominant contact are more constraining.

The constraint index is based upon an evaluation of the focal actor's proportional investment of time and energy (expressed as the proportion of ties) in each contact and the degree to which that contact can be reached through other contacts of the focal actor. Thus, in the closed triad of Figure 1 (p. 3), the focal actor A can reach actor B directly, and indirectly through actor C. A is highly constrained; there is no structural hole for A to exploit. However, in the open triad, A's investment in the tie to B is not made

redundant by a tie between B and C. A has low constraint and can use the structural hole to her advantage. Essentially, the constraint index is calculated by summing the dyadic constraints for the focal actor with each person in the network and squaring the total. Constraint varies from 0 (no constraint) to 1 (complete constraint). Because more constraint means fewer structural holes, to ease presentation and interpretation of the results, the constraint index for each actor was subtracted from one in order to reverse the measure. Thus, lower values of the reversed constraint index implies fewer structural holes and higher values implies more structural holes. Following on the calculation of constraint, hierarchy measures the extent to which the constraint on the focal actor is concentrated in a single contact. As with the constraint index, the hierarchy index was reversed to ease interpretation of results. Thus, lower values of the reversed hierarchy index implies fewer structural holes and higher values implies more structural holes.

Both indices, constraint and hierarchy, are available in UCINET V. The two indices were combined into a single structural holes measure using principal components analysis, a standard data reduction technique.

### Simmelian Ties

Simmelian ties were operationalized in a manner consistent with that suggested by Krackhardt (1996). Recall that two people are Simmelian-tied to one another if they are reciprocally and strongly tied to each other and if they are reciprocally and strongly tied to at least one other third party in common. Krackhardt notes that this definition resembles the definition of a clique in network analysis. A clique is defined as a set of three or more actors all of whom are directly and reciprocally connected to one another.



Thus, each pair of actors in the clique are Simmelian-tied to each other, and, by extension, any pair of actors who are Simmelian-tied are co-members of at least one clique. Thus, the number of each actor's Simmelian ties were calculated using the UCINET V routine, "clique," which generates a co-clique membership table for all actors in the network (Borgatti, Everett, & Freeman, 1992). A count of all the actors to which the focal actor is Simmelian-tied can be derived from the table and expressed as positive integers, which vary from 0 (having no Simmelian ties) to 1-n (where n is the number of actors in the network), implying that the actor has Simmelian ties to all other actors in the network because all the actors are members of one network-wide clique. A normalized index of Simmelian ties was created by dividing each actor's number of Simmelian ties by the total number of actors in the network.

#### Moderating Variable

Task interdependence was operationalized using a five-item scale based on a measure developed by Pearce and Gregerson (1991). They developed a 15-item scale based on Thompson's (1967) theoretical distinctions between sequential and reciprocal interdependence. Using a sample consisting of 290 respondents, Pearce and Gregerson assessed the task interdependence items with exploratory factor analysis using a varimax rotation on all items. Three factors were found with eigenvalues greater than 1.0, together accounting for 54% of the variance. Table 7 shows the rotated factor matrix for the 15 interdependence items. The first factor, interpreted by Pearce and Gregerson as reciprocal interdependence, accounted for 30.7% of the variance ( $\alpha = .76$ ). The second

factor, interpreted as independence accounted for 13.4% of the variance ( $\alpha = .61$ ). The third factor was dropped from the analysis because of its low alpha of .51.

As presented in Chapter 2, reciprocal interdependence represents the most complex form of interdependence, often requiring mutual adjustment as the principal coordination mechanism. Reciprocal interdependence, in turn, may require high levels of cooperation and trust among the interdependent actors. A central premise of this study is that actors working in such interdependent and cooperative work environments will benefit from being Simmelian-tied to others. Thus, the five items comprising the reciprocal interdependence factor in Pearce and Gregerson's scale were used to assess the level of reciprocal task interdependence of each actor, using a seven-point Likert-type scale for each item. Each subject completed the scale. The total task interdependence score for each subject was computed by averaging the scores on the five items comprising the measure, with high scores indicating high reciprocal interdependence.

#### Dependent Variable

As reviewed earlier, numerous potential influences on an actor's effectiveness are theorized to result from the configuration of the actor's social networks. These include possible information benefits, the ability to control the actions of others, the creation of trust, and improved learning. Though Burt (1992) has suggested that these benefits can be found at all levels of analysis (the individual, the group, the firm, the industry, and the market), the focus of this study is the individual actor. Testing the hypotheses requires the operationalization of individual effectiveness as the dependent variable.

Table 7  
Task Interdependence Scale  
From Pearce & Gregerson (1991)

Item	Factor 1	Factor 2	Factor 3
I work closely with others in doing my work.	<u>.78</u>	-.11	.07
I frequently must coordinate my efforts with others.	<u>.74</u>	-.18	.11
My own performance is dependent on <i>receiving</i> accurate information from others.	<u>.69</u>	.06	-.02
The way I perform my job has a significant impact on others.	<u>.62</u>	.18	-.17
My work requires me to <i>consult with others</i> fairly frequently.	<u>.57</u>	-.18	-.20
I work fairly independent of others in my work.	-.12	<u>.73</u>	-.08
I can plan my own work with little need to coordinate with others.	-.09	<u>.73</u>	-.08
I rarely have to <i>obtain information</i> from others to complete my work.	.06	<u>.68</u>	.23
In order to do my job, I need to spend most of my time talking to other people.	-.07	-.16	<u>-.74</u>
In my job I am frequently called on to provide information and advice.	.04	-.05	<u>-.72</u>
I work fairly independently of others in my work.	.18	.70	<u>-.58</u>
Eigenvalue	3.38	1.47	1.04
Percentage of explained variance	30.7%	13.4%	10.0%

Note: Significant loadings at  $p < .05$  are underlined.

Measuring an actor's effectiveness, or performance, in the workplace is problematic and can present significant challenges to the researcher (Cummings, 1978). In some cases, performance measures have been based on quantitative job-related outcomes such as the face value of life insurance policies sold in a month (Hoffman, Jacobs, & Baratta, 1993) or the number of transactions processed by bank tellers (Blau, 1993). For many jobs, such measures are unavailable or inappropriate, and researchers

may construct multi-dimensional scales of individual performance based on job-specific tasks, such as scales measuring the performance of nurses (Meyer, Allen, & Smith, 1993), interviewers (Stamoulis & Hauenstein, 1993), or sales people (Barrick, Mount, & Strauss, 1993). In other cases, the scales may be specific to a job-level such as manager (Barrick & Mount, 1993; Yammarino & Waldman, 1993) or to a particular organization such as the U.S. Army (Borman et al, 1993). However, in studies, such as the present one, incorporating multiple organizations, job levels, and job types, performance is sometimes measured using a set of general items completed by one or a panel of raters (e.g., Liden, Wayne, & Stilwell, 1993; Saavedra & Kwun, 1993; Woehr & Feldman, 1993).

For this study, data was collected in three organizations comprised of 30 – 50 employees each. Two raters, a primary rater and a secondary rater, in each organization were used to rate employees with a 5-item measure. Each item was scored using a 7-point Likert-type scale, anchored by “unsatisfactory performance (1)” and “exceptional performance (7).” The five items were totaled and averaged to create an effectiveness rating for each employee. The primary rater for each employee was the employee’s direct supervisor. The secondary rater was suggested by the organization’s management. In all three organizations, management was careful to note that the secondary raters may not have been in a position to be fully familiar with the performance of all the employees they were asked to rate. A copy of the survey instrument used can be found in Appendix B.

Because the individual effectiveness measure was developed for this study, a pilot study was conducted to assess the scale's internal consistency reliability. Seven items were derived from a review of various performance rating forms used in several organizations. The goal of the pilot study was to refine the scale and identify the five items which, when combined into a single scale, produce the greatest reliability. The pilot study was conducted in an organization of approximately 45 persons. A total of 15 employees were rated by five managers. Each manager rated 6 employees and each employee was rated by two managers. The internal reliability coefficient alpha of the five items used in the survey instrument was .88.

#### Demographic Variables

Although the research questions in this study do not include any demographic variables, it is important to control for possible effects from such variables in order to reduce validity threats. As will be elaborated upon in Chapter 4, the demographic variables constitute a variable set and were entered first in the hierarchical set regression. Doing so ensured that the variance explained in the dependent variable is not accounted for by the demographic variables. The following demographic variables were treated as control variables: age, years of post-high school education, years of full-time work experience, and tenure with the organization. Such demographic attributes may influence a broad generalized indicator of individual effectiveness as was used in this study.

#### Procedure

Participants, subjects and raters, were asked to complete the self-report questionnaires, included in Appendix C, during working hours. Based on the

organization's needs, the survey was administered either during staff meetings or at a time convenient to the employee. Because network analysis requires response rates of 90% or more, the researcher followed-up with all employees to ensure that the survey was returned in a timely manner. The effectiveness ratings were collected from managers separately. Confidentiality of all surveys was assured.

UNT's Institutional Review Board approved the procedures and informed consent forms used in this study. A copy of the approval letter can be found in Appendix D.

### Chapter Summary

This chapter describes the research methodology and design used to test the hypotheses presented in Chapter 2. A traditional network study was conducted, collecting data on all members of several organizational networks. The research design emphasized using relatively simple measures in combination with well-tested techniques for collecting and analyzing relational data.

## CHAPTER 4

### ANALYSIS AND RESULTS

In keeping with Cohen's admonition that "less is more" (1990, p. 1304) except with respect to sample size, this study was constructed so as to utilize two independent variables, one moderating variable, and one dependent variable. As Cohen notes, minimizing the number of variables studied greatly reduces the Type I error rate, the chance of discovering things that are not so. Two statistical techniques were used to test the proposed hypotheses: correlation and hierarchical set regression analysis of variables and variable sets.

#### Analysis of Measures

##### Network Measures

After the surveys were collected, the data on ties among the actors were entered into matrix representations, as reviewed earlier. The matrices, one for each organization, were checked for accuracy and then exported to UCINET V (Borgatti, Everett, & Freeman, 1992), which was used to generate the network measures. Though directed, valued data was gathered in each organization, the UCINET V routines, which calculate the network measures, vary in their requirements as to the data matrix; i.e., in how much of the relational information in the matrix can be used in the analysis. Obviously, the goal is to use as much of the information in the raw matrices as possible, but most routines that calculate network measures require that the data be symmetrical and/or dichotomous.

The calculation of Burt's (1992) measures, constraint and hierarchy, by UCINET V requires that the matrix to be analyzed be dichotomous, but allows it to be directed. Thus, for the purposes of calculating these measures, matrix values were replaced by a 1 if they were greater than 4, and 0 otherwise. Additionally, Burt's measures are calculated such that less constraint and less hierarchy are indicators of more structural holes. Thus, the scaling of the constraint and hierarchy measures was reversed to ease interpretation and make them consistent with the measure of Simmelian ties: higher scores on reversed constraint and reversed hierarchy mean more structural holes, just as higher scores on co-clique membership mean more Simmelian ties. Finally, principal components analysis was used to reduce the two indicators of structural holes, reversed constraint and reversed hierarchy, to a single structural holes measure. The single component represented 55.1% of the variance in the two indicators, with an eigenvalue of 1.10.

UCINET's clique routine, used to calculate the measure of Simmelian ties, requires that the data matrix be binary and symmetrical. The matrices used to calculate the number of Simmelian ties of each actor were symmetrized by taking the product of the dichotomous relations.<sup>7</sup> Thus, all 1's in the matrix used to calculate Simmelian ties represented reciprocal relations where both parties indicated a strength value greater than

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<sup>7</sup> Symmetrizing a dichotomous matrix retains only reciprocal relations. Recall that the network matrices were dichotomized by setting to "1" all relations valued greater than four. Thus, relations valued at four or less were set to "0." Symmetrizing the matrix consists of multiplying the data for both parties in each relation. Thus, if both actors in the dyad report a strong tie ("1"), then the product is "1." However, if either party, or both, report a "0," then their product is "0," indicating that the relationship is not reciprocal.



four, and 0 represented relations where at least one of the two parties indicated relation strength of four or less.

#### Non-network Measures

The task interdependence measure is the mean of the five items comprising the scale. The bivariate correlations among all pairs of the five items varied from a low of .414 to a high of .651. The  $\alpha$  reliability of the task interdependence scale was .848. Further, PCA analysis revealed that a single component represented 62.5% of the variance among the five items, with an eigenvalue of 3.126. No other component had an eigenvalue greater than .70.

For the individual effectiveness measure, two ratings were collected; one from a primary reviewer who was the respondent's supervisor and one from a secondary reviewer. Interviews with managers at each site revealed that in many cases, identifying a suitable secondary reviewer was difficult and sometimes resulted in reviewer scores that could perhaps not be relied upon as much as the primary reviewer. Though the  $\alpha$  reliability of both ratings was high (.96 for both scales), they were not as highly correlated as one might hope ( $r = .592, p < .01$ ). In addition, secondary ratings were obtained on only 96 of the cases, as one secondary reviewer failed to return the ratings. Weighting the two ratings so as to favor the primary reviewer was considered, but there was no basis for determining the appropriate weighting. Relying on the primary reviewer alone was considered, but this would require foregoing all information from the secondary reviewer. Thus, the mean of the two raters was used, and in the cases for which there was no secondary rating, the primary rating was used.

### Correlations and Tests of Group Means

Table 8 presents the correlations of the variables in the study. As one would expect, the demographic variables are significantly correlated. Because data was collected in three organizations, it was necessary to test for differences among the organizations with respect to the variables of interest. As can be seen from Table 9, significant differences of the means exist among the three organizations for all the variables except structural holes and task interdependence. Thus, it is necessary to control for organization when testing the proposed hypotheses.

Table 8  
Correlations Matrix

<i>Variable</i>	<i>Tenure</i>	<i>Educ</i>	<i>Age</i>	<i>Exper</i>	<i>StrHoles</i>	<i>SimmTies</i>	<i>TaskInt</i>
<i>Tenure</i>	--						
<i>Educ</i>	-.285**	--					
<i>Age</i>	.410**	-.329**	--				
<i>Exper</i>	.317**	-.300**	.828**	--			
<i>StrHoles</i>	.247**	.159	.043	.019	--		
<i>SimmTies</i>	.123	.350**	-.053	-.038	.590**	--	
<i>TaskInt</i>	-.006	.041	.158	.196*	.113	.308**	--
<i>Effective</i>	-.016	.387**	.001	.013	.072	.263**	.151

n = 113

\*  $p < .05$

\*\*  $p < .01$

*Tenure* – organization tenure

*Age* – age

*StrHoles* – structural holes

*TaskInt* – task interdependence

*Educ* – years of education

*Experience* – yrs of work experience

*SimmTies* – Simmelian ties

*Effective* – individual effectiveness

Table 9  
Differences Among the Means

	<i>F</i> Between All Orgs.	<i>Mean</i> <i>Difference</i> FW/GTM	<i>Mean</i> <i>Difference</i> FW/NEE	<i>Mean</i> <i>Difference</i> GTM/NEE
<i>Tenure</i>	8.188**	1.58	2.13**	3.75**
<i>Educ</i>	108.867**	3.45**	1.03**	4.48**
<i>Age</i>	10.318**	4.31	4.74*	9.05**
<i>Exper</i>	9.604**	4.61	5.53*	9.14**
<i>StrHoles</i>	2.875	.214	.317	.531*
<i>SimmTies</i>	14.079**	.126**	.020	.147**
<i>TaskInt</i>	.545	.286	.201	.084
<i>Effect</i>	10.815**	.903**	.088	.815**

\*  $p < .05$

\*\*  $p < .01$

“FW/GTM” -- A comparison of the Ft. Worth office and GTM Plastics

“FW/NEE” -- A comparison of the Ft. Worth office and the Needham office

“GTM/NEE” -- A comparison of GTM Plastics and the Needham office

*Tenure* – organization tenure

*Educ* – years of education

*Age* - age

*Experience* -- years of work experience

*StrHoles* – structural holes

*SimmTies* – Simmelian ties

*TaskInt* – task interdependence

*Effective* – individual effectiveness

### Hypothesis Tests

The analyses for hypothesis tests are summarized in Table 10. The following paragraphs will outline the results of each test.

Table 10  
Statistical Tests of Hypotheses

Hypothesis	Statistical Test	Comments
1	Hierarchical Set Regression	<i>Effective</i> is regressed on: demographic variables entered as a set, followed by organization control variables set, followed by <i>StrHoles</i> .
2	Hierarchical Set Regression	<i>Effective</i> is regressed on: demographic variables entered as a set, followed by organization control variables set, followed by <i>SimmTies</i> .
3	Correlation coefficient	Correlation of <i>StrHoles</i> and <i>SimmTies</i> .
4a and 4b	Correlation coefficient	Correlation of <i>StrHoles</i> and <i>TaskInt</i> . Correlation of <i>SimmTies</i> and <i>TaskInt</i> .
5a	Hierarchical Set Regression	<i>Effective</i> is regressed on: demographic variables entered as a set, followed by organization control variables set, followed by <i>StrHoles</i> , followed by <i>TaskInt</i> , followed by the interaction term, <i>StrHoles</i> x <i>TaskInt</i> .
5b	Hierarchical Set Regression	<i>Effective</i> is regressed on: demographic variables entered as a set, followed by organization control variables set, followed by <i>SimmTies</i> , followed by <i>TaskInt</i> , followed by the interaction term, <i>SimmTies</i> x <i>TaskInt</i> .

*StrHoles* – structural holes  
*SimmTies* – Simmelian ties  
*TaskInt* – task interdependence  
*Effective* – individual effectiveness

#### Hypothesis 1

The first hypothesis is that there is a positive relationship between structural holes and individual effectiveness, to be tested using hierarchical set regression. First, the demographic variables (organization tenure, education, age, work experience) were

entered as a set, followed by the organization set (the Ft. Worth organization and the GTM organization)<sup>8</sup>, followed by structural holes, on which was regressed individual effectiveness. In step 1, the demographic set accounted for 17.3% of the variance ( $R^2$ ) in individual effectiveness ( $F = 5.648, p < .01$ ). Of the four demographic variables, only education is a useful predictor of individual effectiveness in the model ( $t = 4.743, p < .001$ ). In step 2, after partialling out the effects of the demographic variables, the change in  $R^2$  from the addition of organization control variables is .037 ( $p < .087$ ). In step 3, the change in  $R^2$  from the addition of structural holes is only .002 ( $p < .601$ ), indicating that Hypothesis 1 is not supported. Analysis of the residuals and the effects of multicollinearity revealed no significant influence on the results of the regression analysis.

### Hypothesis 2

The second hypothesis is that there is a positive relationship between Simmelian ties and individual effectiveness, to be tested using hierarchical set regression. First, the demographic variables (organization tenure, education, age, work experience) were entered as a set, followed by the organization set (the Ft. Worth organization and the

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<sup>8</sup> Organization is a categorical variable, in which membership is exclusive and exhaustive - a subject belongs to one, but only one, organization. The goal in step 2 of the analysis is to partial out all variance which can be explained by the organization to which a subject belongs, after partialling out the effect of the four demographic variables in step 1. There are three organizations and the set "organization" is represented in dummy-coding by including in the set only two of three organizations. The third would be redundant and is omitted. Because the organization variables are dummy coded, the statistical significance of the raw score partial regression coefficients, the B's, for the coded variables is a comparison of the group (Ft. Worth or GTM) to the omitted group (Needham), not to the dependent variable (Cohen & Cohen, 1983). Thus, though by convention, we include the standardized partial regression coefficients, the  $\beta$ 's, in the

Table 11  
Results of Hierarchical Set Regression – Hypothesis 1

Regression	Dependent Variable	Independent Variable	Beta	<i>F</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$	Partial <i>F</i>
Step 1	<i>Effective</i>	<i>Tenure</i>	.063	5.648**	.173	.173	5.648**
		<i>Educ</i>	.447**				
		<i>Age</i>	.056				
		<i>Experience</i>	.080				
Step 2	<i>Effective</i>	Org1 Ft. Worth	.026	4.701**	.210	.037	2.493
		Org 2 GTM	-.302				
Step 3	<i>Effective</i>	<i>StrHoles</i>	-.050	4.041**	.212	.002	.275

n = 113

\*  $p < .05$

\*\*  $p < .01$

*Tenure* – organization tenure

*Educ* – years of education

*Age* - age

*Experience* -- years of work experience

*StrHoles* – structural holes

*SimmTies* – Simmelian ties

*TaskInt* – task interdependence

*Effective* – individual effectiveness

GTM organization), followed by Simmelian ties, on which was regressed individual effectiveness. Because the first two steps are the same as those used to test the first hypothesis, the results for steps 1 and 2 are identical to those obtained when testing the first hypothesis. In step 3, the change in  $R^2$  from the addition of Simmelian ties is only .003 ( $p < .527$ ), indicating that Hypothesis 2 is not supported. Analysis of the residuals and the effects of multicollinearity revealed no significant influence on the results of the regression analysis.

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tables, their statistical significance is not reported.

Table 12  
Results of Hierarchical Set Regression – Hypothesis 2

Regression	Dependent Variable	Independent Variable	Beta	<i>F</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$	Partial <i>F</i>
Step 1	<i>Effective</i>	<i>Tenure</i>	.063	5.648**	.173	.173	5.648**
		<i>Educ</i>	.447**				
		<i>Age</i>	.056				
		<i>Experience</i>	.080				
Step 2	<i>Effective</i>	Org1 Ft. Worth	.026	4.701**	.210	.037	2.493
		Org 2 GTM	-.302				
Step 3	<i>Effective</i>	<i>SimmTies</i>	.065	4.064**	.213	.003	.402

n = 113

\*  $p < .05$

\*\*  $p < .01$

*Tenure* – organization tenure

*Educ* – years of education

*Age* - age

*Experience* -- years of work experience

*StrHoles* – structural holes

*SimmTies* – Simmelian ties

*TaskInt* – task interdependence

*Effective* – individual effectiveness

### Hypothesis 3

Hypothesis 3 proposes that structural holes will be negatively correlated with Simmelian ties. For all cases,  $r = .590$  ( $p < .01$ ), indicating no support for this hypothesis. It will be recalled that structural holes and Simmelian ties are proposed to be contrasting network constructs and, thus, negatively correlated. In this study, the measures of structural holes and Simmelian were positively correlated, a surprising and unexpected result. The implications of this correlation are explored in chapter 5.

#### Hypothesis 4

Hypothesis 4a proposes that structural holes will be negatively correlated with task interdependence, while hypothesis 4b proposes that Simmelian ties will be positively correlated with task interdependence. With respect to hypothesis 4a, for all cases,  $r = .113$  ( $p < .231$ ), indicating no support for this hypothesis. Importantly, especially to this study, task interdependence is negatively skewed ( $-1.081$ ), in that most employees in all three locations indicated relatively high task interdependence (mean = 5.74 on a seven-point scale, s.d. = 1.20). Using a square root transformation of task interdependence, as suggested by Hair et al (1992), for a negatively skewed distribution, made very little change to the correlation of structural holes and task interdependence. There is no support for the hypothesis that structural holes will be negatively correlated with task interdependence. In contrast to the lack of support for hypothesis 4a, the correlation between Simmelian ties and task interdependence indicates strong support for hypothesis 4b, ( $r = .308$  ( $p < .001$ )). This result held when the square root transformation of task interdependence was correlated with Simmelian ties.

#### Hypothesis 5

The fifth, and final, hypothesis, proposes that task interdependence moderates the relationship (1) between structural holes and individual effectiveness and (2) between Simmelian ties and individual effectiveness. Hypothesis 5a proposes that the rate of increase in individual effectiveness with respect to structural holes is greater for low levels than for high levels of task interdependence. Conversely, hypothesis 5b proposes that the rate of increase in individual effectiveness with respect to Simmelian ties is



greater for high levels than for low levels of task interdependence. Put differently, hypothesis 5 proposes that task interdependence is a moderator variable, interacting with both structural holes and Simmelian ties to enhance the predictability of individual effectiveness: (5a) the regression of structural holes on individual effectiveness varies with the level of task interdependence, increasing the strength of their relationship as task interdependence decreases, and (5b) the regression of Simmelian ties on individual effectiveness also varies with the level of task interdependence, increasing the strength of their relationship as task interdependence increases.

In multiple regression analysis, an interaction between two variables is represented by their product, from which are partialled out the effects of the two variables. The significance of the interaction is examined in hierarchical regression by entering each of the two variables separately, followed by the interaction variable (their product). The standard  $F$  test is used to test the significance of the increment to  $R^2$  due to the interaction variable (Cohen & Cohen, 1983).

Thus, hypotheses 5a and 5b were tested using a 5-step hierarchical regression analysis. The results for hypothesis 5a are summarized in Table 13. The results for hypothesis 5b are summarized in Table 14. As can be seen, neither hypothesis was supported by the data. The interaction terms entered in the last step, did not significantly increase  $R^2$ . Analysis of the residuals and the effects of multicollinearity revealed no significant influence on the results of the regression analysis.

Table 13  
Results of Hierarchical Set Regression – Hypothesis 5a

Regression	Dependent Variable	Independent Variable	Beta	<i>F</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$	Partial <i>F</i>
Step 1	<i>Effective</i>	<i>Tenure</i>	.063	5.648**	.173	.173	5.648**
		<i>Educ</i>	.447**				
		<i>Age</i>	.056				
		<i>Experience</i>	.080				
Step 2	<i>Effective</i>	Org1 Ft. Worth	.026	4.701**	.210	.037	2.493
		Org 2 GTM	-.302				
Step 3	<i>Effective</i>	<i>StrHoles</i>	-.050	4.041**	.212	.002	.275
Step 4	<i>Effective</i>	<i>TaskInt</i>	.100	3.699**	.222	.009	1.243
Step 5	<i>Effective</i>	<i>StrHoles x TaskInt</i>	-.141	3.275**	.222	.001	.129

n = 113

\*  $p < .05$

\*\*  $p < .01$

*Tenure* – organization tenure

*Educ* – years of education

*Age* – age

*Experience* -- years of work experience

*StrHoles* – structural holes

*TaskInt* – task interdependence

*Effective* – individual effectiveness

### Summary

This chapter presents the data analysis and results obtained from this study.

Analysis of the network and non-network measures is presented, as well as descriptive summaries of the data and the correlations among the variables of interest. Finally, the results of the hypothesis tests are set forth.

Table 15 summarizes the results of the hypotheses. In this study, Simmelian ties were found to be significantly and positively correlated with task interdependence (hypothesis 4b); however, structural holes were not negatively correlated with task

Table 14  
Results of Hierarchical Set Regression – Hypothesis 5b

Regression	Dependent Variable	Independent Variable	Beta	<i>F</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$	Partial <i>F</i>
Step 1	<i>Effective</i>	<i>Tenure</i> <i>Educ</i> <i>Age</i> <i>Experience</i>	.063 .447** .056 .080	5.648**	.173	.173	5.648**
Step 2	<i>Effective</i>	Org1 Ft. Worth Org 2 GTM	.026 -.302	4.701**	.210	.037	2.493
Step 3	<i>Effective</i>	<i>SimmTies</i>	.065	4.064**	.213	.003	.402
Step 4	<i>Effective</i>	<i>TaskInt</i>	.084	3.649**	.219	.006	.798
Step 5	<i>Effective</i>	<i>SimmTies</i> x <i>TaskInt</i>	.168	3.226**	.220	.001	.099

n = 113

\*  $p < .05$

\*\*  $p < .01$

*Tenure* – organization tenure

*Educ* – years of education

*Age* - age

*Experience* -- years of work experience

*SimmTies* – Simmelian ties

*TaskInt* – task interdependence

*Effective* – individual effectiveness

interdependence as predicted (hypothesis 4a). Neither structural holes nor Simmelian ties were found to be an estimator of individual effectiveness (hypotheses 1 and 2, respectively), nor were they negatively correlated with each other (hypothesis 3).

Finally, no support was found for the proposition that task interdependence moderates the

relationship between structural holes and individual effectiveness (hypothesis 5a) or the relationship between Simmelian ties and individual effectiveness (hypothesis 5b).

Table 15  
Summary of Results

Hypotheses	Results
H1: There is a positive relationship between structural holes and individual effectiveness.	No support
H2: There is a positive relationship between Simmelian ties and individual effectiveness.	No support
H3: The extent to which a network is characterized by structural holes is negatively related to the extent to which a network is characterized by Simmelian ties.	No support
H4a: Networks characterized by structural holes are negatively related to task interdependence among network actors.	No support
H4b: Networks characterized by Simmelian ties are positively related to task interdependence among network actors.	Support ( $p < .001$ )
H5a: The level of task interdependence will moderate the relationship between structural holes and individual effectiveness; the rate of increase in individual effectiveness with respect to structural holes is greater for low levels than for high levels of task interdependence.	No support
H5b: The level of task interdependence will moderate the relationship between Simmelian ties and individual effectiveness; the rate of increase in individual effectiveness with respect to Simmelian ties is greater for high levels than for low levels of task interdependence.	No support

## CHAPTER 5

### DISCUSSION

The network perspective on organizational phenomena presented in this study encompasses two key themes: (1) the structural dimensions of social capital matter, and (2) the importance of the relationship between interdependence and social capital. All but one of the proposed hypotheses, however, were not supported. This chapter will explore some limitations in the data and their effect on the theoretical contributions and findings of this study, threats and limitations to the results, implications of the study, and suggestions for future research.

#### Data Limitations and Theoretical Contributions

As noted, the first key theme of this study is that the structural dimensions of social capital matter; specifically, the structure of an actor's social networks in the workplace significantly influences the actor's effectiveness on the job. Unfortunately, there was no support for hypotheses that structural holes and Simmelian ties would be significantly associated with individual effectiveness. The following paragraphs will examine possible explanations for this lack of support.

#### Structural Holes and Individual Effectiveness

No support was found for the proposition that the degree to which an actor's social network is characterized by structural holes is significantly and positively associated with individual effectiveness. In order to understand better this lack of

association, additional analyses were undertaken. First, the hierarchical set regression analysis outlined in Chapter 4 was repeated for each organization, enabling an examination of how the relationship of these variables might differ among the three organizations in the study. However, no significant effect was found in any of the organizations. Further, the elimination of two outliers whose residuals consistently lay more than three standard deviations from the mean in regression analyses did not significantly change the results obtained in the analysis of all cases, nor in the organization-level analyses.

When considering possible explanations for the lack of significant results, it is important to bear in mind that despite the recent theoretical attention being paid to Burt's structural hole construct by organization researchers (Brass, Butterfield, & Skaggs, 1998; Gulati, 1998; Nahapiet & Ghoshal, 1998; Sparrowe & Liden, 1997), there are no published empirical field studies utilizing the structural holes construct in an organizational setting other than Burt's own studies (1992, 1997a, 1997b), which are based on a single dataset. Thus, despite the lack of support for the structural holes hypotheses, an important contribution of this study is its use of the structural holes construct in a field setting. The following paragraphs will examine important distinctions between this study and Burt's work which may explain, in part, the lack of results obtained in this study.

First, Burt's (1992, 1997a, 1997b) data is from a sample of managers in a large company, using an unusual methodology similar to that used in the 1985 General Social Survey. Burt asked the managers to report on their own relationships by listing those to

whom they were tied, and also on the relations among those to whom the manager was tied. Though this approach enables the researcher to collect data in a population of unrestricted size, Krackhardt (1995) notes that there are two inherent limitations in the methodology. First, Burt necessarily assumes that the manager can and will report reliably on relationships to which the manager is not a party, which is a problematic assumption not supported by other research (Krackhardt, 1990; Wasserman & Faust, 1994). Second, Burt's analysis is very unlikely to extend past the primary and secondary ego networks of the managers surveyed, thereby ignoring relationships which might be important to the structure of the larger network. In addition, Burt's methodology necessitated the use of name-generators, which results in dichotomous data.<sup>9</sup> Only the presence of a tie is detected, not its strength. As Krackhardt (1995) notes, Burt sacrificed the quality of the network information in order to gain a broader sample. Conversely, this study examined three smaller organizations but collected very rich network data – valued data from all members of the organization on all possible relationships in the organization. Additional research is needed to ascertain the degree to which these differences in methodology might be an important factor in the differences in results. For example, Burt's inability to collect valued data may mask important subtleties in the pattern of strong and weak ties. Further, relationships which are overlooked in Burt's

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<sup>9</sup> It will be recalled that network survey instruments fall into two broad categories. The researcher can use a name-generating survey, in which the respondents are asked to provide the names of all those with whom they have a relationship, as did Burt (1992, 1997a, 1997b). Alternatively, the researcher can provide the respondents with a list of all possible network members and ask them to indicate those with whom they have a relationship and the strength of that relationship, as was done in this study.

data collection may be useful in understanding the complete pattern of relationships in the organization.

One potentially important difference between Burt's study (1992, 1997a, 1997b) and this study is that Burt included only managers in his sample, using their promotion rates as the dependent variable, whereas, in this study, all organizational actors were included, using a measure of their individual effectiveness as the dependent variable. Burt found that more structural holes were associated with early promotion, which might lead one to conclude that managers will tend to have more structural holes than non-managers. This expectation was borne out in this study, as a *t*-test revealed significant differences in the structural holes of managers and non-managers ( $t = 4.501, p < .001$ ). Further, regression analysis revealed that managerial status (manager v. non-manager) is a significant estimator of structural holes, after controlling for the demographic variables and organization ( $\Delta R^2 = .036, p < .05$ ). Nonetheless, structural holes was not found to be an estimator of individual effectiveness for managers or for non-managers.<sup>10</sup> Though promotion rates, as used by Burt (1992), may be an indicator of individual effectiveness, it is possible that individual effectiveness encompasses sub-constructs which are not significantly associated with an actor's structural holes.

There also are potentially important differences in the range of data in this study compared to Burt's (1992) study. In Burt's sample, the values of constraint ranged from .16 to .45, whereas in this study, the values of constraint ranged from .103 to only .233.

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<sup>10</sup> The hierarchical set regression used to test hypothesis 1 was undertaken for the sub-group "managers" and then for the sub-group "non-managers." For neither group, was structural holes a significant estimator of individual effectiveness.



The restriction of variance in this study, compared to Burt's study, may be a partial explanation for the lack of significant findings in this study. The restriction of variance may result from methodological differences between this study and Burt's study, as outlined above. Even more striking than the restriction of the constraint values, in Burt's sample, the values for the hierarchy index ranged from .16 to .45, whereas in this study, the values for hierarchy ranged from .003 to .081. As noted, these differences may be due to data collection methods or to real differences among the organizations and actors sampled. In any event, the lack of variance in the structural holes measure in this study restricts the prospects of finding significant results in analyses utilizing the measure.

One possible explanation for the lack of association between structural holes and individual effectiveness in this study is consistent with the theory presented. One of the principal theoretical contributions of this study is its proposition that structural holes will be associated with low levels of task interdependence and that Simmelian ties will be associated with high levels of task interdependence. Put another way, it is suggested that under low conditions of task interdependence, the networks of effective actors will be characterized by structural holes. In this study, actors in all three organizations reported high levels of task interdependence. This was not expected, as GTM Plastics, the manufacturing firm, was included in the study specifically because, based on interviews with management and direct observation of work, it was believed that self-reports of task interdependence would be low. Instead, reported task interdependence was as high at GTM as in the Ft. Worth and Needham offices of the software firm. Indeed, task interdependence was the only variable in the study for which the means did not

significantly vary between the organizations. It is possible that the lack of association between structural holes and effectiveness results from the absence of low task interdependence actors in the analysis. Clearly, additional research focused on organizations where tasks are characterized by low interdependence is needed or, perhaps, studies using multiple departments of a single organization where the departments differ significantly in levels of task interdependence.

Finally, as noted earlier, very few network studies use broad indicators of performance or effectiveness as the dependent variable. Using a general measure of effectiveness, such as that used in this study, presents risks to the researcher. The number of variables that potentially influence an actor's effectiveness on the job is necessarily large, with the result being that the unique variance accounted for by any single variable is likely to be quite small. Thus, the non-significant results in this study may suggest that future research utilizing the structural holes or the Simmelian ties construct examine the use of dependent variables with more limited scope. For example, Burt (1992, 1997a, 1997b) used promotion rates as the dependent variable, which would perhaps have more limited scope than a measure of individual effectiveness. Similarly, it has been suggested that Simmelian ties are important to building trust (Coleman, 1990), which promotes several desirable outcomes. Thus, one might explore whether Simmelian ties are associated with beneficial outcomes that benefit from the creation of trust, such as effective learning (Argyris & Schon, 1978; Sitkin, Sutcliffe, & Schroeder, 1994), stronger norms (Coleman, 1990), and more cooperation (Dodgson, 1993; Krackhardt & Stern, 1988; Ring & Van de Ven, 1994).

### Simmelian Ties and Individual Effectiveness

Contrary to the analysis of structural holes, additional regression analyses indicated that there exists some support for the proposition that Simmelian ties is significantly associated with individual effectiveness. As reported in Chapter 4, of the four demographic variables included in Step 1 of the hierarchical regression model used to test the second hypothesis, only education was a significant estimator of individual effectiveness. Thus, in order to preserve as many degrees of freedom as possible, a hierarchical regression analysis partialling out only education in step 1 was performed. Because the omitted demographic variables accounted for very little of the variance in individual effectiveness, eliminating them from the analysis made little change in the results. Nevertheless, of the 113 cases in the analysis, there were two cases whose residual errors consistently lay more than three standard deviations from zero, substantially influencing the regression analyses. When all cases were analyzed and step 1 of the analysis partialled out only education, the  $\Delta R^2$  from the addition of Simmelian ties to the model in step 3 was .010,  $p < .262$ . When the two outliers were eliminated, the  $\Delta R^2$  from the addition of Simmelian ties to the model in step 3 increases to .023,  $p < .068$ . Though not statistically significant, the variance in individual effectiveness explained by Simmelian ties in this regression model provides some indication that there may be an association between Simmelian ties and individual effectiveness under conditions of high task interdependence.

Additionally, as noted earlier, using the mean of the two raters as the dependent variable, individual effectiveness, is not entirely satisfactory. Several secondary raters

did not return all or some of their ratings and others indicated their lack of confidence in some of their ratings. Thus, though the correlation of the two ratings is significant ( $r = .599, p < .001$ ), the Kappa<sup>11</sup> of .154, indicates, at best, only a modest association between the raters and falls far short of the .60 threshold suggested by Hartmann (1977) as indicating an acceptable level of inter-rater agreement. As set forth by Doty, Glick, & Huber (1993), there can be advantages to using a single rater, one of which is to increase the probability that the most knowledgeable rater is providing the information. Thus, the hierarchical regression was performed using only the primary rating as the dependent variable. When partialling out only education and omitting the two outliers from the analysis, the  $\Delta R^2$  from the addition of Simmelian ties to the model in step 3 increases to .030,  $p < .050$ . Though this regression analysis incorporates several important modifications to the analysis used to test hypothesis 2, the statistical significance of the variance in individual effectiveness explained by the addition of Simmelian ties to the model suggests that there is an association between Simmelian ties and individual effectiveness under conditions of high task interdependence.

At the level of the organization, regression analyses also provide some support for the notion that there exists an association between Simmelian ties and individual effectiveness. In Ft. Worth, none of the demographic variables are significant estimators of individual effectiveness, thus the simple bivariate correlation between Simmelian ties and individual effectiveness can be examined. Using all cases in Ft. Worth,  $r = .142$  ( $p$

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<sup>11</sup> Cohen's Kappa coefficient corrects the observed agreement between the raters for chance. +1 indicates perfect agreement and -1 indicates perfect disagreement. A value of 0 indicates agreement that one would expect by chance.

<.432). However, the residual of one outlier in Ft. Worth consistently lies more than three standard deviations from zero in regression analyses and substantially influences the correlation. Elimination of that single case increases  $r$  to .289 ( $p < .109$ ), indicating that the level of Simmelian ties accounts for 8.4% of the variance in individual effectiveness. Similar results are found in GTM, where Simmelian ties accounts for 6.3% of the variance ( $r = .250$ ,  $p < .101$ ) in individual effectiveness, when an outlier in GTM (also consistently more than three standard deviations from the mean in regression analyses) is eliminated. Though the correlations in Ft. Worth and GTM are not statistically significant (which may be, in part, due to the reduced sample size), their magnitude lends some support to the notion that Simmelian ties is associated with individual effectiveness. However, similar results were not found in Needham.

It is unclear why Needham differs from Ft. Worth and GTM with respect to the association between Simmelian ties and individual effectiveness. The cases in Ft. Worth and in GTM were combined into a single group which was then compared to Needham. As a group, employees at FW and GTM are significantly older, less educated, more experienced, and have been with the organization longer than the employees in Needham. Future research should examine more closely the relationship of these demographic variables to the development, value, and use of Simmelian ties.

### Simmelian Ties and Structural Holes

One surprising result of this study was the positive correlation of structural holes and Simmelian ties ( $r = .590$ ,  $p < .001$ ). In an attempt to better understand this finding, the structural holes measure was decomposed into its two underlying indicators:

constraint and hierarchy. In addition, these measures were then obtained from the same network matrices as the Simmelian ties measure.<sup>12</sup> When constraint and hierarchy are compared with their factor, which was used as the structural holes measure, it becomes clear that the positive correlation with Simmelian ties is carried by constraint. The reversed constraint measure (high scores mean high constraint) is highly correlated with Simmelian ties ( $r = .562, p < .001$ ), whereas the reversed hierarchy measure (high scores mean high hierarchy) is not ( $r = .066, p < .489$ ). Recall that the constraint index is based upon an evaluation of the focal actor's proportional investment of time and energy (expressed as the proportion of ties) in each contact and the degree to which that contact can be reached through other contacts of the focal actor. The hierarchy index measures the extent to which the constraint on the focal actor is tied to a single other actor. Whereas constraint is significantly associated with Simmelian ties, the degree to which the constraint is concentrated in a single contact is not.

Inadequate operationalization of the structural hole and Simmelian tie constructs could be one explanation for the positive correlation of the measures used in this study. As will be reviewed later in this chapter, difficulties exist with the structural holes measures and their ability to adequately capture the richness of Burt's (1992) theory.

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<sup>12</sup> It will be recalled that the original structural holes measure was based on dichotomized, but not symmetrical matrices, whereas the Simmelian ties measure required that the matrices be symmetrized, as well as dichotomized. In this decomposition analysis, the dichotomous, symmetrical matrices used to generate the Simmelian ties measure also were used to generate measures of constraint and hierarchy, which were then reversed in order to ease interpretation. The reversal conforms the direction of the structural holes scores and the Simmelian tie scores; i.e., by reversing the constraint and hierarchy measures, higher scores mean more structural holes. Thus, the predicted correlation between structural holes and Simmelian ties would be negative.

Further theory development may be helpful also in explaining the positive correlation of structural hole and Simmelian ties. In particular, one area needing further theory development is the notion that there is a strong distinction between being Simmelian tied in a single clique and being Simmelian tied as a bridge between many cliques. It is theoretically possible that a person who is tied to many cliques could be high in Simmelian ties and also high in structural holes. Figure 8 is helpful in illustrating this idea. In Network A of Figure 8, the focal actor has four structural holes and no Simmelian ties. In Network B, the focal actor still has four structural holes, but is now Simmelian tied to eight other actors and is a bridge between four cliques, each of which is a closed Simmelian triad. Network C is a further extension of this idea: still four structural holes, but the focal actor is now tied to 16 people and is a bridge between four cliques of five actors each. In Network C, each clique is what amounts to a Simmelian clique, in that each actor is Simmelian tied to every other actor. Recall that two people are Simmelian tied if they are reciprocally and strongly tied to each other and at least one other person.

Burt (1992) uses Figure 8 to illustrate network redundancy, but it also shows how an actor could enjoy structural hole benefits while also bridging otherwise disconnected Simmelian triads and cliques. Admittedly, organizational networks, including those in this study, are much more complex than the simplified illustrations of Figure 8. Nonetheless, Figure 8 gives some sense of how an actor might be high in structural holes and also high in Simmelian ties. As noted, these measures of structural holes and Simmelian ties have been little used in empirical research. Sorting out the constructs

embodied in structural holes, Simmelian ties, and Simmelian triads, as well as the various operationalizations which could be employed, will be an important avenue of research for those seeking to understand the network perspective on organizations.

### Task Interdependence

As reported in chapter 4, there is strong support for the hypothesis that Simmelian ties will be positively correlated with task interdependence. Conversely, no support was found for the hypothesis that structural holes is negatively correlated with task interdependence. Similar to the analysis undertaken to examine the positive correlation of structural holes and Simmelian ties, the structural holes measure was decomposed into its two indicators, constraint and hierarchy, which were then correlated with task interdependence. For all cases, reversed constraint was significantly and positively correlated with task interdependence,  $r = .307$  ( $p < .01$ ), while reversed hierarchy was negatively correlated with task interdependence,  $r = -.139$  ( $p < .142$ ). These results are consistent with those found in each organization. Thus, just as constraint and hierarchy differ importantly in their association with Simmelian ties, they also differ in their association with task interdependence. Similar to the possible explanations reviewed earlier of the positive correlation between structural holes and Simmelian ties, these findings may result from inadequate operationalizations of the structural holes construct or inadequate theoretical distinctions among the structural constructs. The fact that constraint and Simmelian ties are both significantly correlated with task interdependence, in addition to being significantly and positively associated with each other, lends further



support to the notion that these network constructs are not as theoretically distinct as suggested by much of the literature.

Additionally, as reported in Chapter 4, there was no support found for the proposition that task interdependence moderates the strength of the associations between structural holes and individual effectiveness and between Simmelian ties and individual effectiveness. This result may be due, at least in part, to the statistical difficulties of detecting moderator effects. As reported by McClelland and Judd (1993), field researchers often find it difficult to detect interaction effects due to the statistical noise inherent to such studies. McClelland and Judd suggest that interaction tests in field studies will often be less than 20% as efficient as comparable experimental designs. They suggest that, when testing interaction effects, field researchers rely on large sample sizes and utilize a  $p$ -value of  $<.10$ . This is a particularly difficult problem for network researchers since, as noted earlier, there are no accepted sampling methods, making it difficult to detect significant interactions. In the present study, with 113 cases, the interaction effects were not significant using  $p <.10$ .

In summary, the mixed results of this study may indicate that an important line of future research will be to draw with greater care the theoretical distinctions between structural holes and Simmelian ties and the relationship of these structural constructs to other important organizational constructs. In addition, empirical and theoretical work is needed to ensure that the operationalizations of these constructs capture fully all dimensions of the constructs, providing researchers with reliable and valid measures.

### Potential Limitations and Threats to Validity

The principle threats to the validity of the study derive from the use of survey instruments to collect the network and non-network data. These methods give rise to problems specific to the analysis of network data, specifically informant accuracy, and more general difficulties typical of survey-based field studies, such as common method variance and single-source bias.

Self-reports of the presence or absence of social ties are the most common method used to gather network data. Most often, the respondent is asked to enumerate those persons to whom the respondent had direct ties of a specific kind. Thus, a key question in network analysis is whether such self-reports accurately describe the underlying relations in the network. Early research on limited samples provided evidence that people are not very good at reporting on their interactions in particular situations (Wasserman & Faust, 1994). However, later research by Freeman, Romney, and colleagues (Freeman & Romney, 1987; Freeman, Romney, & Freeman, 1987; Hammer, 1985) argue that individual or dyadic interactions are not of primary concern to network researchers. Rather, they argue that researchers are interested in the relatively stable interaction patterns that constitute the true network. Their research has demonstrated that informant accuracy of stable informal structures, especially reports of reciprocated ties, is much more reliable than reports of specific interactions (Scott, 1991).

An important feature of this study served to mitigate further the risks of informant accuracy. Respondents were given a list of all the potential network members and were

asked to rate the strength of their relationship; thus, respondents were not relied upon to accurately recall the names of those to whom they are tied.

Common method variance poses a particular threat to survey research in that it can lead the researcher to mistakenly conclude that there is a significant relationship between two variables when the relationship is actually a statistical artifact. Such an artifact can result when two variables are measured using the same instrument by a single source. Because both measures come from the same source, any problem with the source contaminates both measures, presumably in the same degree and direction (Aviolo, Yammarino, & Bass, 1991; Campbell & Fiske, 1959; Mitchell, 1985). Specific factors that can lead to common method and single source bias include consistency motif (the respondent is biased by a desire to answer the items consistently), the transient mood of the respondent, social desirability, and the effect of various cues in the setting where the survey is administered (Podsakoff & Organ, 1986). Various remedies have been suggested to reduce common methods variance, including statistical and post-hoc remedies, as well as procedural remedies. Several aspects of this research design served to mitigate the validity threats posed by common methods variance.

As noted earlier, several network measures were used. Measures of constraint and hierarchy were used as indicators of the structural holes measure, and co-clique membership was used as the operationalization of Simmelian ties. All these measures are based on assessing reciprocal ties; thus, data from both actors in the relation is used to create the measure of the relation. Consequently, the measures are not based on data from a single source.

As to the non-network measures, the dependent variable, individual effectiveness, was assessed using two raters for each actor in the network and inter-rater reliability was reported. Because effectiveness is being rated by someone other than the subject providing the measures for the independent variables, single source bias is not a problem. In addition, by using two raters for each subject and using a multiple item scale (Spector, 1987), risks of rater bias were diminished as well, though, as noted, the ratings by the secondary raters were problematic. Some of the secondary raters failed to rate the performance of all employees and other raters indicated a low level of confidence in their ratings. These problems are consistent with some of those which led Doty, Glick, & Huber (1993) to suggest using a single informant. Nonetheless, as noted, there are important benefits from using multiple raters. The problems encountered in this study could perhaps have been mitigated by using more than two raters, better rater training, and more careful selection of secondary raters, bearing in mind the realities of organizational field research.

Of all the variables in this study, the proposed moderating variable, task interdependence, was most susceptible to common methods variance in that it was measured using a single scale constituting a self-report by each respondent, who also provided the independent variables. However, the dependent variable was provided by an independent set of raters using a different method, eliminating common methods variance with respect to the dependent variable. In addition, even though the moderating variable and independent variables were provided by the same source, they were collected with different methods and represent different constructs. As noted earlier, a

five-item Likert-type scale was used to assess task interdependence, while the independent variables of interest are all network variables, using specialized means of data collection and analysis. Thus, using the continuum of single source effects suggested by Avolio et al. (1991), the procedures used minimize the risk of common methods variance.

Other procedural methods for reducing further the risk of single-source bias, such as escalating the unit of analysis by aggregating individual data into grouped data or collecting data at different times or places (Podsakoff & Organ, 1986), were not feasible. Still, there are reasons to have confidence in the validity of the task interdependence measure. First, task interdependence was assessed using a multiple-item scale, which is preferable to a single-item measure (Spector, 1987). Second, because actors build personal networks based on their perceptions of what will be most useful to themselves, their own perceptions of task interdependence are most relevant to the analysis.

### Implications and Directions

All those who work in organizations know the important role that informal social networks play in the functioning of organizations. Still, given the relative dearth of empirical field work in organizations, actors have had little guidance in how best to shape their own networks. The purpose of this research was to draw with care the theoretical distinctions between Burt's (1992) structural holes construct and Krackhardt's (1996) Simmelian ties construct, and test the proposition that task interdependence moderates the influence of each on individual effectiveness. These are important questions not only for those who practice management, but for organizational researchers as well. The

increasing attention being paid to network analysis and to socially oriented organizational constructs, such as trust and social capital (Nahapiet & Ghoshal, 1998), highlight the need for theory development and empirical work in this area. The somewhat perplexing results in this study suggest several important directions for future research in this emerging discipline.

Certainly, the most surprising result in this study was that the measures of structural holes and Simmelian ties were not negatively correlated, indeed they were strongly and positively correlated. As developed in the literature, theorists propose that the structural holes and Simmelian ties constructs embody quite different conceptions of structure (Brass, Butterfield, and Skaggs, 1998; Sparrowe & Liden, 1997). Though the strong correlation of structural holes and Simmelian ties may have resulted from the methodologies employed or the organizations studied, this is unlikely. As reviewed in chapter 3, typical network data collection methodologies were used. In addition, the organizations studied were from different industries and locales. More likely explanations for this result are difficulties with the operationalizations of the constructs or incomplete theoretical understandings of them. The following paragraphs will consider each possibility.

As operationalized by Burt (1992, 1997a, 1997b) and in UCINET V (1992), the structural holes algorithm is based upon a matrix of directed, but not valued ties. Thus, capturing differences among strong and weak ties is problematic. Because the relational data must be dichotomous (a tie simply exists or not exists), one cannot consider the differing effects of strong and weak ties, even though Burt (1992) takes pains to note that

strong ties are important, in that “information benefits are maximized in a large diverse network of trusted contacts” (p. 47), while weak ties are the bridges to important sources of new and non-redundant information. However, using the structural holes measures developed to date, the analyst can examine strong ties or weak ties, but not both. One avenue to capture both strong tie and weak tie structure in the same structural hole analysis would be to use a network measure which would indicate the level of structural holes and allow the interpretation of valued ties. Brass, Butterfield, & Skaggs (1998) and Brass (1992) suggest that betweenness centrality<sup>13</sup> may be a useful indicator of structural holes, in that an actor high in betweenness centrality is able to move information between the otherwise unconnected cliques, as well as employ control strategies that create competitive advantages similar to those created by structural holes. However, though the algorithm for computing betweenness centrality can utilize directed data, the data must also be dichotomous. The algorithm for computing a second betweenness measure, flow betweenness centrality (Freeman, Borgatti, & White, 1991), allows the use of valued data, but the matrix must be symmetrical. In short, though several network measures exist which capture something of the structural holes construct, no available measure fully operationalizes the richness and nuance of Burt’s construct. It may be that better understanding and use of the structural hole construct must await development of measures which allow the differentiation between strong and weak ties, as well as

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<sup>13</sup> Betweenness is one aspect of an actor’s centrality in the network and measures the extent to which the actor lies on the shortest path between pairs of other actors. The greater the extent to which actors in the network must go through the focal actor to reach others in the network, the higher the focal actor’s betweenness centrality. See figure 7 for diagrams illustrating betweenness centrality.

reciprocal and non-reciprocal ties. As Salancik (1995) has noted, much of network analysis has consisted of the mathematical relationships among extant measures. However, organizational researchers need access to robust, valid, and reliable operationalizations of network constructs.

In addition to further development of network construct operationalizations, theory development is needed as well. As reviewed earlier in this chapter, one avenue for future research will be to develop more fully the theoretical distinctions between structural holes and Simmelian ties. Is there a theoretical basis for the notion that an actor could be high in both? Under what conditions would this be the case? What would be the implications in the workplace? A second avenue of research will be to explore the functioning of these constructs in differing types of networks.

Every organization is made up of a diverse set of informal networks, across which advice, influence, work, communications, friendship and other resources flow. When considering these networks, it is useful to differentiate between instrumental and affective networks. Actors use instrumental networks to get things done in the organization, while affective networks carry resources such as social support and friendship. Though there may be similarities between an actor's instrumental and affective networks, they are not typically the same, but, instead, embody important theoretical distinctions (Ibarra, 1992; Krackhardt & Stern, 1988). Burt's (1992) structural holes theory emphasizes instrumental action – optimizing the network for the accumulation of non-redundant information and the opportunity to maximize bargaining power by exploiting the lack of connections between others. Selecting those with whom the focal actor wishes to have a



strong relationship becomes a matter of achieving those instrumental ends. To some, this may seem a somewhat emotionally barren approach to social participation in the workplace; e.g., selecting your closest relationships on the basis of what they can do for you. More to the point, an actor does not so much select her closest contacts, as develop them over time in an evolutionary trust-building process, culminating in a few stable and close relationships in which each actor identifies with the other's intentions and desires, enabling the flow of fine-grained information and obligations without surveillance or monitoring (Lewicki & Bunker, 1996). Though Burt (1992) acknowledges that trust is critical to the honoring of obligations between contacts, he focuses on optimizing network size and diversity under a "presumption of trust" (p. 47). This presumption skips over several important questions which may have important implications for structural hole theory.

Some theorists (Lewicki & Bunker, 1996; Shapiro, Sheppard, & Cheraskin, 1992; Wicks, Berman, & Jones, 1999) suggest that trust in the workplace develops in stages, from a weak form of trust wherein the risks are carefully calculated and safeguards are used, to a middle stage wherein knowledge of the other person enables predictions about behavior, to a strong form of trust wherein the trust is based upon a mutual identification of goals and intentions. How do those stages influence the nature of structural holes and their value to an actor? Since, in structural holes theory, trust is critical to the relationship of the focal actor with each primary contact, does this necessarily make it more likely that structural hole benefits will be found in affective networks rather than instrumental networks. Indeed, consistent with this notion, Burt (1997b), in recent work

using the same database as used in earlier structural hole work (1992, 1997a), compared the structural hole effects in managers' networks of their personal relations to the structural hole effects in networks of their corporate authority relations. He found that the structural hole benefits were strong for the networks of personal relations, but non-existent for the networks of authority relations. This lends support to the notion that the importance of trust to the operation of structural hole effects increases the importance of affective relations. Yet, Burt (1992) notes that structural holes efficiency, as proposed, "mixes poorly with friendship" (p. 24). Further, increasing trust levels increase the likelihood that the triad (see Figure 1) will close, as strong relations tend to be transitive (Davis, 1979), thereby reducing or eliminating structural hole effects. These theoretical considerations and the mixed results of this study suggest that more careful theoretical exploration of the role of trust in the development and maintenance of structural hole effects is needed.

### Summary and Conclusion

This study examined two contrasting theories of how informal structures emerge within organizations and how those structures may benefit or constrain the abilities of actors to achieve their desired ends. In Burt's (1992) world, the networks of successful actors derive from individualistic motives and emerge from the actor's calculated selection of primary contacts so as to maximize the actor's accumulation of valuable information and bargaining advantage. For Simmel (1950), Coleman (1990), and Krackhardt (1996), actor's networks serve to maintain stable collective structures that facilitate cohesiveness, trust, and cooperation. In its theory presentation, this study

suggested that individualistic structures, exemplified by structural holes, would be associated with low levels of task interdependence and that collective structures, exemplified by Simmelian ties, would be associated with high levels of interdependence. Further, it was suggested that both network constructs are associated with individual effectiveness. As presented in chapter 4, hypotheses derived from these propositions were tested in a field setting and minimal support was obtained. Chapter 5 explored possible explanations for these results and suggested several important directions for future research.

Salancik (1995) rightly criticizes network analysts for their preoccupation with applying diverse network measures rather than developing network theories that contribute uniquely to our understanding of organizations. As outlined in this chapter, the mixed results obtained in this study indicate the need for substantial theoretical development of the structural hole and Simmelian tie constructs, as well as their operationalization. Network theorists need to consider the role of network content, e.g., instrumental and affective, in the shaping of structural hole and Simmelian tie theory. The relationship between these seemingly contrasting theories of structure should be more carefully considered. Network analysts need to begin with the constructs and work from them to operationalizations which can capture the richness of the theories.

Finally, one needs to consider the practical implications of this work. The issues examined in this chapter highlight the emerging nature of this discipline and the difficulty of making normative statements. Of the hypotheses tested, statistical significance was found only for the proposed association between Simmelian ties and task

interdependence. Nonetheless, additional analysis found some indications that Simmelian ties may be associated with individual effectiveness in high task interdependence organizations, as all the organizations in this study proved to be. Thus, one might recommend that organizational actors in highly interdependent environments participate in tight, cohesive cliques in which all members are strongly and reciprocally tied to one another. Still, it seems clear that the network perspective needs much development before it can make meaningful, valid, actionable, and non-obvious recommendations to those working in organizations.

APPENDIX A  
POWER ANALYSIS

## Power as a Function of Sample Size

### For Multiple Regression

		Increment to R-Squared			Cumulative R-Squared		
		Number Variables in Set	Increment to R-Squared	Power for Increment	Cumulative Number Variables	Cumulative R-Square	Power for Cumulative R-Squared
1	Demographic variables	4	0.02	0.25	4	0.02	0.25
2	Structural holes	1	0.02	0.42	5	0.04	0.45
3	Task interdependence	1	0.02	0.42	6	0.06	0.61
4	Interaction	1	0.02	0.42	7	0.08	0.73
	Alpha= 0.05	Designated sets ( 1 to 4), Number variables = 7, Increment= 0.08 N Cases = 150, Power= 0.73					
		Power computations: Non-central F, Model 2 error					

### Power as a Function of Sample Size

N (1)	Power
20	.093
40	.183
60	.288
80	.399
100	.506
120	.604
140	.690
160	.763
180	.821
200	.868
220	.904
240	.931
260	.952
280	.966
300	.977
320	.984
340	.989
360	.993
380	.995
400	.997
420	.998
440	.999
460	.999
480	.999
500	1.000

Power for 7 variables yielding increment of .08

Total variable in equation = 7 and total  $R^2 = .08$

Alpha = .05 Tails = 2, Power computations: Non-central F, Model 2 error

## Power as a Function of Sample Size

### For Multiple Regression

		Increment to R-Squared			Cumulative R-Squared		
		Number Variables in Set	Increment to R-Squared	Power for Increment	Cumulative Number Variables	Cumulative R-Square	Power for Cumulative R-Squared
1	Demographic variables	4	0.13	1.00	4	0.13	1.00
2	Structural holes	1	0.13	1.00	5	0.26	1.00
3	Task interdependence	1	0.13	1.00	6	0.39	1.00
4	Interaction	1	0.13	1.00	7	0.52	1.00
	Alpha= 0.05	Designated sets ( 1 to 4), Number variables = 7, Increment= 0.52 N Cases = 150, Power= 1.00					
		Power computations: Non-central F, Model 2 error					



### Power as a Function of Sample Size

N (1)	Power
18	.642
20	.743
22	.821
24	.879
26	.920
28	.948
30	.967
32	.979
34	.987
36	.992
38	.996
40	.997
42	.998
44	.999
46	1.000
48	1.000
50	1.000

Power for 7 variables yielding increment of .52

Total variable in equation = 7 and total  $R^2 = .52$

Alpha = .05 Tails = 2, Power computations: Non-central F, Model 2 error

## Power as a Function of Sample Size

### For Multiple Regression

		Increment to R-Squared			Cumulative R-Squared		
		<b>Number Variables in Set</b>	<b>Increment to R-Squared</b>	<b>Power for Increment</b>	<b>Cumulative Number Variables</b>	<b>Cumulative R-Square</b>	<b>Power for Cumulative R-Squared</b>
1	Demographic variables	4	0.08	0.92	4	0.08	0.92
2	Structural holes	1	0.08	0.98	5	0.16	1.00
3	Task interdependence	1	0.08	0.98	6	0.24	1.00
4	Interaction	1	0.08	0.98	7	0.32	1.00
	Alpha= 0.05	Designated sets ( 1 to 4). Number variables = 7, Increment= 0.32 N Cases = 150, Power= 1.00					
		Power computations: Non-central F, Model 2 error					

### Power as a Function of Sample Size

N (1)	Power
18	.297
20	.358
22	.419
24	.479
26	.535
28	.589
30	.639
32	.685
34	.727
36	.764
38	.798
40	.828
42	.854
44	.877
46	.896
48	.913
50	.928
52	.940
54	.950
56	.959
58	.966
60	.973
62	.978
64	.982
66	.985
68	.988
70	.990
72	.992
74	.994
76	.995
78	.996
80	.997
82	.998
84	.998
86	.998
88	.999
90	.999

Power for 7 variables yielding increment of .32

Total variable in equation = 7 and total  $R^2 = .32$

Alpha = .05 Tails = 2, Power computations: Non-central F, Model 2 error

## APPENDIX B

### COVER LETTER AND SURVEY INSTRUMENT USED WITH RATERS

Body of the Cover Letter (on UNT letterhead)

Dear Participant,

I truly appreciate your time and involvement in this research project, which is being conducted as part of the requirements for me to earn my Ph.D. in Organization Theory and Policy from the University of North Texas.

Your honest responses to each statement and question are extremely important to this project's outcome. You can be assured of complete confidentiality – at least two raters will rate each employee. No individual responses will be published and the raw information will be accessible only to me and the University of North Texas faculty on my dissertation committee. This packet contains only several sections for rating several different employees. Please read the instructions carefully. It is very important that you answer every statement or question.

It will take you approximately 20-30 minutes to complete the survey. In addition, your participation is voluntary. You may withdraw at any time without penalty or prejudice. If you have questions concerning this study, please contact me at 972-625-3781.

Thank you again for your time and effort.

Sincerely,

Scott L. Engle

**Please note that this project has been reviewed and approved by the University of North Texas Committee for the Protection of Human Subjects.**

## Survey

### Instructions:

You have been asked to provide simple performance ratings on a small number of employees at [XXX Organization]. Below, you will see that there are seven items/"questions" for each person. Please rate each person by circling the appropriate number, ranging from "1" (unsatisfactory performance) to "7" (exceptional performance).

EMPLOYEE NAME TO BE INSERTED HERE	Unsatisfactory			Satisfactory			Exceptional
1. The degree to which this individual accomplishes the expected amount of work within established time frames.	1	2	3	4	5	6	7
2. The degree to which this individual accomplishes what is expected of him/her.	1	2	3	4	5	6	7
3. The degree to which this individual produces accurate and quality work that meets specified requirements.	1	2	3	4	5	6	7
4. The degree to which this individual is able to meet the demands of his/her job.	1	2	3	4	5	6	7
5. The degree to which this individual regularly and consistently meets the performance standards and requirements of his/her position.	1	2	3	4	5	6	7

EMPLOYEE NAME TO BE INSERTED HERE	Unsatisfactory			Satisfactory			Exceptional
1. The degree to which this individual accomplishes the expected amount of work within established time frames.	1	2	3	4	5	6	7
2. The degree to which this individual accomplishes what is expected of him/her.	1	2	3	4	5	6	7
3. The degree to which this individual produces accurate and quality work that meets specified requirements.	1	2	3	4	5	6	7
4. The degree to which this individual is able to meet the demands of his/her job.	1	2	3	4	5	6	7
5. The degree to which this individual regularly and consistently meets the performance standards and requirements of his/her position.	1	2	3	4	5	6	7

EMPLOYEE NAME TO BE INSERTED HERE	Unsatisfactory			Satisfactory			Exceptional
1. The degree to which this individual accomplishes the expected amount of work within established time frames.	1	2	3	4	5	6	7
2. The degree to which this individual accomplishes what is expected of him/her.	1	2	3	4	5	6	7
3. The degree to which this individual produces accurate and quality work that meets specified requirements.	1	2	3	4	5	6	7
4. The degree to which this individual is able to meet the demands of his/her job.	1	2	3	4	5	6	7
5. The degree to which this individual regularly and consistently meets the performance standards and requirements of his/her position.	1	2	3	4	5	6	7

EMPLOYEE NAME TO BE INSERTED HERE	Unsatisfactory			Satisfactory			Exceptional
1. The degree to which this individual accomplishes the expected amount of work within established time frames.	1	2	3	4	5	6	7
2. The degree to which this individual accomplishes what is expected of him/her.	1	2	3	4	5	6	7
3. The degree to which this individual produces accurate and quality work that meets specified requirements.	1	2	3	4	5	6	7
4. The degree to which this individual is able to meet the demands of his/her job.	1	2	3	4	5	6	7
5. The degree to which this individual regularly and consistently meets the performance standards and requirements of his/her position.	1	2	3	4	5	6	7

EMPLOYEE NAME TO BE INSERTED HERE	Unsatisfactory			Satisfactory			Exceptional
1. The degree to which this individual accomplishes the expected amount of work within established time frames.	1	2	3	4	5	6	7
2. The degree to which this individual accomplishes what is expected of him/her.	1	2	3	4	5	6	7
3. The degree to which this individual produces accurate and quality work that meets specified requirements.	1	2	3	4	5	6	7
4. The degree to which this individual is able to meet the demands of his/her job.	1	2	3	4	5	6	7
5. The degree to which this individual regularly and consistently meets the performance standards and requirements of his/her position.	1	2	3	4	5	6	7



EMPLOYEE NAME TO BE INSERTED HERE	Unsatisfactory			Satisfactory			Exceptional
1. The degree to which this individual accomplishes the expected amount of work within established time frames.	1	2	3	4	5	6	7
2. The degree to which this individual accomplishes what is expected of him/her.	1	2	3	4	5	6	7
3. The degree to which this individual produces accurate and quality work that meets specified requirements.	1	2	3	4	5	6	7
4. The degree to which this individual is able to meet the demands of his/her job.	1	2	3	4	5	6	7
5. The degree to which this individual regularly and consistently meets the performance standards and requirements of his/her position.	1	2	3	4	5	6	7

EMPLOYEE NAME TO BE INSERTED HERE	Unsatisfactory			Satisfactory			Exceptional
1. The degree to which this individual accomplishes the expected amount of work within established time frames.	1	2	3	4	5	6	7
2. The degree to which this individual accomplishes what is expected of him/her.	1	2	3	4	5	6	7
3. The degree to which this individual produces accurate and quality work that meets specified requirements.	1	2	3	4	5	6	7
4. The degree to which this individual is able to meet the demands of his/her job.	1	2	3	4	5	6	7
5. The degree to which this individual regularly and consistently meets the performance standards and requirements of his/her position.	1	2	3	4	5	6	7

## APPENDIX C

### COVER LETTER AND SURVEY INSTRUMENT USED WITH SUBJECTS

Body of the Cover Letter (on UNT letterhead)

Dear Participant,

I truly appreciate your time and involvement in this research project, which is being conducted as part of the requirements for me to earn my Ph.D. in Organization Theory and Policy from the University of North Texas.

Your honest responses to each statement and question are extremely important to this project's outcome. This survey is different from others you have probably participated in. Because the research is focused on the structure of relationships in the workplace, I need to know your name. Nonetheless, you can be assured of complete confidentiality – no individual responses will be published and the raw information will be accessible only to me and the University of North Texas faculty on my dissertation committee. This packet contains three sections addressing your relationships in the workplace, the way that you work with others, and some information about yourself. It is very important that you answer every statement or question.

It will take you approximately 30-45 minutes to complete the survey. In addition, your participation is voluntary. You may withdraw at any time without penalty or prejudice. If you have questions concerning this study, please contact me at 972-625-3781.

Thank you again for your time and effort.

Sincerely,

Scott L. Engle

**Please note that this project has been reviewed and approved by the University of North Texas Committee for the Protection of Human Subjects.**

## Survey

Name: \_\_\_\_\_

Department: \_\_\_\_\_

### **SECTION 1: YOUR INTERPERSONAL RELATIONSHIPS WITHIN [Name of Organization]:**

The purpose of this section of the survey is to assess the “strength” of your relationship with others in [Name of organization]. Most people maintain a wide variety of relationships in the workplace; some are “stronger” and some are “weaker.” “Strong” relationships are typically characterized by frequent contact, emotional closeness, and long duration. We trust and confide in those with whom we have strong relationships. “Weak” relationships are typically characterized by infrequent contact and emotional distance. Those with whom we have weak relationships might be acquaintances of ours, or those for whom we can only associate a name with a face. Below you will find a roster of everyone in [Name of organization]. On a scale of 1 to 7, with “1” being a very weak relationship and “7” being a very strong relationship, please circle the rating that best describes the strength of your relationship with each person. If you do not know the person, please put a check mark in the box, “Don’t know.” Also, please be careful to rate your relationship with everyone on the roster. Complete information is very important in this study. Thanks you for your time.

	Don't know this person	Very Weak			Neither Weak nor strong			Very Strong
1. John Doe.	Don't know.	1	2	3	4	5	6	7
2. Jane Doe	Don't know.	1	2	3	4	5	6	7
3. John Doe	Don't know.	1	2	3	4	5	6	7
4. Jane Doe	Don't know.	1	2	3	4	5	6	7
5. John Doe.	Don't know.	1	2	3	4	5	6	7
6. Jane Doe	Don't know.	1	2	3	4	5	6	7
7. John Doe.	Don't know.	1	2	3	4	5	6	7
8. Jane Doe	Don't know.	1	2	3	4	5	6	7
9. John Doe.	Don't know.	1	2	3	4	5	6	7
10. Jane Doe	Don't know.	1	2	3	4	5	6	7
11. John Doe.	Don't know.	1	2	3	4	5	6	7
12. Jane Doe	Don't know.	1	2	3	4	5	6	7
And so on . . .	Don't know.	1	2	3	4	5	6	7
50. Steve Taylor	Don't know.	1	2	3	4	5	6	7

**SECTION 2: THE WAY YOU WORK WITH OTHERS WITHIN YOUR ORGANIZATION:** The purpose of this section of the survey is to assess how you typically work with others in *[Name of Organization]* your organization. For the following statements, please indicate how strongly you agree or disagree with each by circling the appropriate number, ranging from “1” (Strongly Disagree) to “7” (Strongly Agree). Thanks!

	Strongly Disagree						Strongly Agree
1. I work closely with others in doing my work.	1	2	3	4	5	6	7
2. I frequently must coordinate my efforts with others.	1	2	3	4	5	6	7
3. My own performance is dependent on <i>receiving</i> accurate information from others.	1	2	3	4	5	6	7
4. The way I perform my job has a significant impact on others.	1	2	3	4	5	6	7
5. My work requires me to <i>consult with others</i> fairly frequently.	1	2	3	4	5	6	7

**SECTION 3: DEMOGRAPHIC INFORMATION:** For the questions below, please fill in each blank or check the appropriate response category.

1. Number of Years You've Been Employed At *[Name of Organization]*: \_\_\_\_\_ years
2. Number of Years of Post-High School Education: \_\_\_\_\_ years
3. Your Gender:  
 \_\_\_\_\_ (1) Female  
 \_\_\_\_\_ (2) Male
4. Your Current Age: \_\_\_\_\_ years
5. Number of Years of Full-time Work Experience: \_\_\_\_\_ years

Thank you!!

APPENDIX D

INSTITUTIONAL REVIEW BOARD APPROVAL



University of North Texas  
*Sponsored Projects Administration*

June 26, 1998

Scott Engle  
5201 Southern Hills Dr.  
Frisco, TX 75034

Re: Human Subjects Application No. 98-110

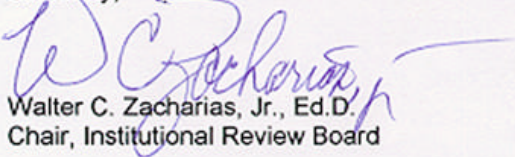
Dear Mr. Engle:

As permitted by federal law and regulations governing the use of human subjects in research projects (45 CFR 46), I have conducted an expedited review of your proposed project titled "Structural Holes and Simmelian Ties: Exploring the Structural Influence of Task Interdependence on Effectiveness." The risks inherent in this research are minimal, and the potential benefits to the subjects outweigh those risks. The submitted protocol and informed consent forms are hereby approved for the use of human subjects on this project.

The UNT IRB must re-review this project prior to any modifications you make in the approved project. Please contact me if you wish to make such changes or need additional information.

If you have any questions, please contact me.

Sincerely,



Walter C. Zacharias, Jr., Ed.D.  
Chair, Institutional Review Board

WZ:sb

cc: IRB Members

P.O. Box 305250 • Denton, Texas 76203-5250  
(940) 565-3940 • Fax (940) 565-4277 • TDD (800) 735-2989  
e-mail: lane@abn.unt.edu

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